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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY

OF

WASHINGTON

VOLUME VII

1892

WASHINGTON, D. C.
PUBLISHED BY THE SOCIETY
1892–1893

COMMITTEE ON PUBLICATIONS.

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F. H. KNOWLTON.

L. O. HOWARD.

T. S. PALMER.

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LIST OF THE

OFFICERS AND COUNCIL

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON,

ELECTED JANUARY 9, 1892.

OFFICERS.

President.

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Secretaries.

FREDERICK V. COVILLE.
F. A. LUCAS.

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THEOBALD SMITH.
F. W. TRUE.
C. D. WALCOTT.
C. A. WHITE.*
LESTER F. WARD.*

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* Ex-Presidents of the Society.

LIST OF THE

PERMAMENT COMMITTEES

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

FOR 1892.

COMMITTEE ON COMMUNICATIONS.

B. E. FERNOW, *Chairman.*

F. A. LUCAS. ERWIN F. SMITH.

COMMITTEE ON PUBLICATIONS.

CHARLES D. WALCOTT, *Chairman.*

FREDERICK V. COVILLE. F. H. KNOWLTON.

L. O. HOWARD. T. S. PALMER.

DELEGATES TO THE JOINT COMMISSION OF SIX SCIENTIFIC SOCIETIES OF WASHINGTON.

C. HART MERRIAM, *ex officio.*

RICHARD RATHBUN. LESTER F. WARD.

VOL. VII, PP. VII-XV JULY, 1892

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

CONSTITUTION AND BY-LAWS.

CONSTITUTION.

ARTICLE I.—*Name.*

The name of this Society is the Biological Society of Washington.

ARTICLE II.—*Object.*

The object of the Society is the increase and diffusion of biological knowledge.

ARTICLE III.—*Members.*

The members of the Society shall be persons who are interested in biological science. There may be two classes of members, active and corresponding.

ARTICLE IV.—*Officers.*

The officers of the Society shall be a President, four Vice-Presidents, a Recording Secretary, a Corresponding Secretary, and a Treasurer.

There shall be a Council, consisting of the officers of the Society, the ex-presidents, and five additional members.

The officers and additional members of the Council shall be elected annually by ballot, and shall hold office until their successors are elected. The Council shall have power to fill vacancies.

ARTICLE V.—*Amendments.*

This Constitution shall not be amended except by a three-fourths vote of the members present at an annual meeting for the election of officers, and notice of the proposed amendment must be submitted in writing at a regular meeting of the Society at least four weeks previously.

BY-LAWS.

ARTICLE I.—*Members.*

Active members only shall be entitled to vote and to hold office.

Persons residing outside of the District of Columbia may become corresponding members of the Society. They may attend its meetings, and take part in and contribute to its proceedings. Corresponding members may be transferred to active membership by the Council.

Nominations for membership shall be signed by three active members of the Society, and submitted to the Council through the Recording Secretary. They shall not receive action until they have been before the Council at least two weeks. After recommendation by a majority of the Council present at a regular meeting, nominations shall be acted upon at the next ensuing regular meeting of the Society, a majority vote of the members present being necessary to an election.

Notice of resignation of membership shall be given in writing to the Council.

ARTICLE II.—*Officers.*

The President shall preside at the meetings of the Society and of the Council. He shall appoint all committees except such as are otherwise provided for; and, jointly with the Recording Secretary, shall sign all written contracts and other obligations of the Society. In the absence of the President, his duties shall be performed by one of the Vice-Presidents.

The Recording Secretary shall keep minutes of the meetings of the Society and Council.

The Corresponding Secretary shall issue notices for the meetings of the Society and Council, shall notify members of their election, and conduct the correspondence. He shall have the

custody of the records, except the minutes, and the accounts of the Treasurer.

The Treasurer shall collect all moneys and, under the direction of the Council, disburse the same. He shall report upon the state of the funds at each annual meeting, and at other times if required. The accounts of the Treasurer shall be audited by a committee of three, to be appointed at least two weeks previous to the annual meeting. In the absence of the Treasurer, the Recording Secretary is authorized to receive the dues of members.

Article III.—*Dues.*

The annual dues of active members shall be three dollars, payable at the beginning of the year, and no member in arrears shall be entitled to vote at the annual meeting for the election of officers. Members shall receive the publications of the Society only for the years for which their dues are paid. The names of those two years in arrears shall be dropped from the list of members.

The annual dues of Corresponding members shall be three dollars.

Any member not in arrears may become a life member on the payment of fifty dollars at one time, and be relieved from all further dues and other assessments. All moneys received in payment of life memberships shall be invested in a permanent publication fund.

The fiscal year shall terminate with the annual meeting.

Article IV.—*Meetings.*

The regular meetings of the Society shall be held at 8 o'clock p. m. on alternate Saturdays from October to May, inclusive, unless otherwise ordered by the Council. The place of meeting will be designated by the Council.

Special meetings may be called by the President, with the approval of the Council.

The regular meetings, with the exception of the annual meeting, shall be devoted to the presentation and discussion of scientific subjects.

The regular order of business shall be as follows:

1. Reading of minutes.
2. Reports of committees.

3. Balloting for members.
4. Miscellaneous business.
5. Reading of papers, discussions, and exhibition of specimens

This order of business may be suspended at any time by a two-thirds vote of the members present.

The annual meeting for the election of officers shall be the last stated meeting in December.

The regular meeting preceding the annual meeting shall be set apart for the delivery of the President's annual address, unless a special meeting is called for the purpose.

Persons interested in biological science may, upon invitation of a member, be present at any meeting of the Society except the annual meeting.

ARTICLE V.—*Annual Meeting and Election of Officers.*

The order of proceedings at the annual meeting shall be as follows:

1. Reading of the minutes of the last annual meeting.
2. Presentation of the annual reports of the Secretaries.
3. Presentation of the annual report of the Treasurer.
4. Announcement of the names of members who, having complied with Article III of these By-Laws, are entitled to vote on the election of officers.
5. Election of President.
6. Election of four Vice-Presidents.
7. Election of one Recording and one Corresponding Secretary.
8. Election of Treasurer.
9. Election of five additional members of the Council.
10. Consideration of amendments to the Constitution.
11. Reading of the rough minutes of the meeting.

The election of officers will be conducted as follows:

Nominations shall be made in each case by informal ballot and the result announced by the Secretary, after which the first formal ballot shall be taken.

In balloting for Vice-Presidents and the five additional members of the Council, each member shall write on one ballot as many names as there are officers to be elected, namely, four on the first ballot for Vice-Presidents, and five on the first ballot for members of the Council; and on each subsequent ballot as

many names as there are officers still to be elected. Those persons who receive a majority of the votes cast shall be declared elected.

If in any case the informal ballot result in giving a majority for one or more of the persons balloted for, it may be declared formal by a majority vote.

Article VI.—*Committees.*

There shall be two standing committees, one on Communications and one on Publications.

Article VII.—*Communications.*

All communications presented at the meetings of the Society must be authorized by the Committee on Communications, and the said committee shall arrange the program for each meeting, unless otherwise directed by the Council.

Article VIII.—*Publications.*

The Committee on Publications shall have charge of all publishing, in accordance with the rules relating to publications.

Article IX.—*Sections.*

Sections representing special branches of biology may be established by the Council upon the written recommendation of ten members of the Society.

Article X.—*Unassigned Business.*

All the business of the Society not otherwise provided for shall be transacted by the Council.

Article XI.—*Amendments.*

These By-Laws may be amended by a majority vote of the members present at a meeting of the Society, due notice thereof having been given in writing at least four weeks previously.

RULES RELATING TO PUBLICATION.

Form of Publication.

Section 1. The Biological Society of Washington will continue to publish a volume entitled *Proceedings of the Biological Society of Washington.*

Section 2. This volume shall be published in covered parts or brochures, consecutively paged for each volume. The brochures shall be designated by volume numbers and limiting pages, and each shall bear a special title setting forth the contents and authorship, as well as the title of the volume and the imprint of the Society, and, in addition, the precise date of publication.

Section 3. A brochure may consist of a single memoir or article, in which case the author may order or authorize the order at his expense of any number of copies; and the shorter papers, abstracts, notes, and miscellaneous matter may be collected and issued as brochures uniform with those containing the memoirs.

Section 4. The brochures shall be arranged for gathering into volumes, each comprising the issue of a calendar year; and about the close of each year there shall be published, in a brochure arranged to complete the volume, a title-page, a list of contents, and an index for the corresponding volume, together with an abstract of the proceedings of the Society and list of officers and, if ordered, a list of the members for the year, and a copy of the constitution and by-laws and rules governing the Society.

Matter of Publication.

Section 5. The matter published in the Proceedings of the Biological Society of Washington may comprise (1) original communications prepared by members or guests of the Biological Society presented at meetings by title or otherwise; (2) abstracts of papers read and discussions made before the Society prepared or revised by authors; (3) administrative records of the Society, including condensed minutes of meetings prepared by the Secretaries; (4) lists of members, by-laws and rules, resolutions of permanent character, etc.; and (5) title-pages, lists of contents, and indexes for each volume.

Section 6. Matter designed for publication in the Proceedings may be transmitted to the Committee on Publication, either direct or through the Secretaries of the Society; soon as may be thereafter the Committee shall decide on the desirability and expediency of the publication or refer the matter to the Council for decision. If the matter is accepted it shall be published as soon as practicable; if rejected it shall be returned to the author. Communications from non-members and translated memoirs shall be published only upon unanimous vote of the Committee on Publications and by specific authority from the Council. The Committee on Publications or the Council may refer any communication to special committees for examination.

Section 7. Matter offered for publication in the Proceedings of the Biological Society of Washington becomes thereby the property of the said Society, and shall not be published elsewhere prior to publication in the Proceedings except by consent of the Society.

Section 8. Matter accepted for publication in the Proceedings of the Biological Society of Washington shall be either printed and issued as soon as possible as a memoir-brochure or reserved for the next brochure of miscellaneous contents, at the option of the Committee on Publications. Proofs of letter-press and illustrations shall be submitted to authors or persons designated by authors whenever practicable; but printing shall not be delayed more than one week by reason of absence or incapacity of authors.

Manner of Publication.

Section 9. The text of each brochure of the Proceedings of the Biological Society of Washington shall begin under its proper title, on an odd-numbered page, bearing at its head the title of the volume, the limiting pages, and date of publication. Each such brochure shall be accompanied by the illustrations pertaining to it, the plates consecutively numbered for the volume, and each brochure may contain a synoptic list of contents, prepared by the author, and, at the option of the Committee on Publications, an alphabetic index, provided the same be prepared by the author. Each brochure shall be enclosed in a cover, conforming as nearly as may be to the present covers of the Proceedings, bearing at the head of its title-page the title of the Proceedings, the volume, the limiting pages, the date of publication, and, below, the imprint of the Society. Other cover

pages may bear a list of the publications of the Society; but nothing else of bibliographic or other permanent value shall be printed on the covers unless the same be printed also in the body of the volume to which the brochure belongs.

Section 10. The author of each memoir shall be authorized to order, through the Committee on Publications, any edition of exactly similar brochures, in exactly similar covers, to be printed as author's separates, at cost of paper and press-work; but no author's separates of the memoir-brochures shall be issued except in this regular form. Fifty copies of an author's edition of the presidential address shall be provided for and presented to the President.

Section 11. At least two Proceedings-brochures may be published during each year, the first about the close of the meeting season of the Society, and the second about the close of the calendar year.

Section 12. Authors of papers in the Proceedings-brochures shall have the privilege of ordering, through the Committee on Publications, at their own cost, any number of separate copies, provided these separates bear the original pagination and a printed reference to the serial and volume from which they are extracted.

Section 13. About the end of each year a volume-title-page, general list of contents and illustrations of the volume, a list of officers, an abstract of the proceedings for the year, a general index to the volume, and, if ordered, a list of the members of the Society and the constitution and by-laws shall be printed and issued as a separate brochure. All of this matter, except the index, shall be arranged for binding at the beginning of the volume under a distinct Roman pagination; but the index shall take the regular Arabic pagination at the end of the volume. The title-page shall bear the name of the Committee on Publications, and the obverse shall bear the imprimatur of the Council and the printer's card.

Section 14. The bottom of each signature and of each initial page shall bear a signature-mark, giving an abbreviated title of the serial, the volume, and the year; and every page shall be numbered, the initial and subtitle-pages at the bottom.

Section 15. The page-head titles shall be: On even-numbered pages, name of author and catch-title of paper; on odd-numbered pages, catch-title of contents of page.

Section 16. The typography, paper, and general make-up shall conform, except as herein otherwise specified, as nearly as may be to the Proceedings of the Biological Society of Washington as heretofore published. The printed page shall be enlarged from 6½ inches to 7 inches in length, and the leading reduced to six lines and a lead to the inch.

Section 17. The date of publication of each brochure shall be that upon which the edition is delivered to the Committee on Publications.

Section 18. The brochures shall be distributed immediately by the Committee on Publications to members of the Society, subscribers, and exchanges from a list furnished by the Secretaries, and the undistributed copies of each edition shall be turned over to the Secretaries.

Section 19. The regular edition shall be five hundred and twenty-five copies.

Section 20. The Committee on Publications shall keep a record of all matter published wholly or in part under the auspices of the Society, whether the same be author's editions of the memoir-brochures, author's extracts from the Proceedings-brochures, or any other matter printed from type originally composed for the volume.

Section 21. The volume shall be mailed free to members of the Society not in arrears for dues, and for an annual price of three dollars to regular subscribers. The separate brochures may be sold, to the number of not more than ten to each individual, at an advance on cost of 25 per cent. to members and 75 per cent. to non-members of the Society; and either separate brochures or complete volumes may be sold to dealers at the usual discount for matter of the same class.

Section 22. The Committee on Publications may introduce, at discretion, advertisements of proper character, on pages provided for the purpose, not taking the regular pagination of the Proceedings, at the usual rates for such service.

VOL. VII, PP. XVII-XXIV APRIL 8, 1893

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

PROCEEDINGS.

January 9, 1892. *186th Meeting.*

TWELFTH ANNUAL MEETING.

The PRESIDENT in the chair and 23 persons present. The annual reports of the Treasurer and Recording Secretary were presented, and the officers for the year 1892 elected. (See page v.)

January 23, 1892. *187th Meeting.*

The PRESIDENT in the chair and 18 persons present.

COMMUNICATIONS.

C. W. STILES: "Notes on Parasites; *Myzomimus*, gen. nov."[1] Discussed by Dr. THEOBALD SMITH.

THEODOR HOLM: "Studies of the Morphological Identity of the Stamens." Discussed by Mr. COVILLE, Dr. STILES, and Dr. MERRIAM.

[1] Notes on parasites: 4, Preliminary note on *Myzomimus* gen. nov. type species *M. scutatus* (Mueller, 1869), Stiles, 1892. Journ. Comp. Medicine and Veterinary Archives, 1892, pp. 65–67, 1 fig.

On the Anatomy of *Myzomimus scutatus*. Festschrift zum siebenzigsten geburtstage Rudolf Leuckarts, 1892, pp. 126–133, taf. xvii, figs. 1–29.

THEOBALD SMITH: "Peculiar Forms of Red Corpuscles in Mammalia in Anæmic Conditions."[1]

February 6, 1892. *188th Meeting.*

The PRESIDENT, Dr. C. HART MERRIAM, delivered the annual address, entitled "The Geographic Distribution of Life in North America."[2]

The meeting was held in the law lecture-room of Columbian University, there being 132 persons present.

February 20, 1892. *189th Meeting.*

The PRESIDENT in the chair and 41 persons present.

A committee, consisting of Mr. WALCOTT, Mr. LUCAS, and Mr. RATHBUN, was appointed to revise the Constitution and By-Laws of the Society.

COMMUNICATIONS.

W. H. DALL: "Factors in the Distribution of Animal Life as Illustrated by Marine Forms." Discussed by Mr. WALCOTT, Mr. FERNOW, and Dr. DALL,

F. A. LUCAS: "On *Carcharodon mortoni*, Gibbes."[3]

J. M. HOLZINGER: "On the Identity of *Asclepias stenophylla* and *Acerates auriculata*."[4] Discussed by Professor WARD, Mr. FERNOW, Mr. COVILLE, Mr. WALCOTT, Dr. DALL, Dr. CURTICE, Professor SEAMAN, Dr. ERWIN F. SMITH, Dr. BAUER, Mr. LUCAS, Mr. BANKS, and Dr. STILES.

March 5, 1892. *190th Meeting.*

The PRESIDENT in the chair and 35 members present.

COMMUNICATIONS.

FREDERICK V. COVILLE: "Conditions Affecting the Distribution of Plants in North America." Discussed by Mr. LUCAS, Mr.

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[1] On changes in the red blood corpuscles in the pernicious anæmia of Texas cattle fever. Trans. of the Assoc. of American Physicians for 1891.

Bulletin No. 1, Bureau of Animal Industry: Investigations into the nature, causation, and prevention of Texas or Southern cattle fever (pp. 56, 68). by Theobald Smith and F. L. Kilborne, Washington.

[2] Proc. Biol. Soc. Wash., vol. vii, Apr. 13, 1892, pp. 1–64, 1 map.

[3] On *Carcharodon mortoni*. Proc. Biol. Soc. Wash., vol. vii, July, 1892, pp. 151, 152.

[4] The identity of *Asclepias stenophylla* and *Acerates auriculata*. The Botanical Gazette, vol. xvii, April, 1892, pp. 124, 125.

Walcott, Dr. Merriam, Dr. Stejneger, Professor James, Dr. Dall, Professor Riley, Mr. Fernow, and Mr. Coville.

Charles Hallock (read by Mr. Lucas): "The Physiology of a Pocoson." Discussed by Mr. Waite and Mr. William Palmer.

Vernon Bailey: "The Homes of Our Mammals."

Theodor Holm: "The Flora of Nova Zembla." Discussed by Mr. Swingle.

March 19, 1892. *191st Meeting.*

The President in the chair and 70 persons present.

COMMUNICATIONS.

Lester F. Ward: "The Biological Basis of Psychology." Discussed by Dr. Reyburn, Mr. Fernow, Professor Riley, Mr. McGee, Dr. Dall, Dr. Merriam, and Professor Ward.

C. D. Walcott: "On the Discovery of Certain Cambrian Fossils on the Coast of Massachusetts."[1]

F. H. Knowlton: "The Fossil Flora of the Bozeman Coal Field."[2] Discussed by Professor Ward, Mr. Walcott, and Mr. Knowlton.

C. W. Stiles: "Notes on Parasites—*Strongylus rubidus*."[3]

April 2, 1892. *192d Meeting.*

The President in the chair and about 65 persons present.

COMMUNICATIONS.

C. V. Riley: "The Interdependence of Plants and Insects."[4] Discussed by Professor Ward, Dr. Gill, and Professor Riley.

C. Hart Merriam: "The Distribution of Tree Yuccas." Discussed by Mr. Gilbert, Mr. Coville, Mr. Van Deman, Mr. Hasbrouck, and Professor Riley.

H. E. Van Deman: "Variations in the Fruit of *Hicoria Pecan*." Discussed by Professor Seaman, Professor Ward, Mr.

[1] Note on Lower Cambrian fossils from Cohassett, Mass. Proc. Biol. Soc. Wash., vol. vii, July 27, 1892, p. 155.

[2] The Fossil Flora of the Bozeman Coal Field. Proc. Biol. Soc. Wash., vol. vii, July 27, 1892, pp. 153, 154.

[3] Albert Hassall and C. W. Stiles: *Strongylus rubidus*, a new species of Nematode, parasitic in pigs. The Journal of Comparative Medicine and Veterinary Archives, 1892, pp. 207–209, figs. 1–3.

[4] Proc. Biol. Soc. Wash., vol. vii, May 28, 1892, pp. 81–104.

Van Deman, Mr. Simpson, Mr. Hasbrouck, Mr. Fernow, and Mr. Brunk.

April 16, 1892. *193d Meeting.*

The President in the chair and 19 persons present.

COMMUNICATIONS.

C. W. Stiles: "Notes on Parasites: *Tænia ovilla* in its Relation to Blanchard's Classification."[1] Discussed by Professor Doran, Dr. Gill, and Dr. Stiles.

Frederick V. Coville: "Flora of the High Sierra Nevada of California." Discussed by Mr. Fairchild and Mr. Mann.

Frederick V. Coville: "New Plants from California, Nevada, Utah and Arizona."[2] Discussed by Dr. Merriam, Mr. Fairchild, Mr. White, and Mr. Coville.

Erwin F. Smith: "A Review of Baillon's Botanical Dictionary." Discussed by Dr. Gill, Professor Seaman, and Dr. Smith.

J. N. Rose: "Mexican Leguminosæ, with Notes on Dr. Palmer's Collection.

April 30, 1892. *194th Meeting.*

The President in the chair and 48 persons present.

The proposed new Constitution and By-Laws, recommended by the Council for adoption, were read.

COMMUNICATIONS.

W J McGee: "The Distribution of Land, Water, and Ice on This Continent in Later Geological Periods." Discussed by Dr. Merriam, Mr. Gilbert, and Mr. McGee.

Erwin F. Smith: "The Relations of Plants to the Soil." Discussed by Mr. Fairchild.

May 14, 1892. *195th Meeting.*

The President in the chair and 23 persones present.

COMMUNICATIONS.

W. H. Seaman: "The Photogenic Organs of Fire Flies." Discussed by Mr. Mann, Dr. Gill, Dr. Merriam, and Dr. Theobald Smith.

[1] Notes sur les Parasites: Sur le Tænia giardi. Compt. rend. d. l. Soc. d. Biologie, Paris, 1892, pp. 664, 665 (note préliminaire).

[2] Description of new plants from Southern California, Nevada, Utah, and Arizona. Proc. Biol Soc. Wash., vol. vii, May 18, 1892, pp. 65–80.

C. Hart Merriam: "A New Prairie Dog from Mexico."[1] Discussed by Professor Ward.

Charles Hallock (read by Mr. Lucas): "Where Salt-water Fishes Hide: Results of Deep-water Seining." Discussed by Dr. Gill.

Theodor Holm: "Additions to the Flora of Washington."[2] Discussed by Professor Ward.

Frederick V. Coville: "The Use of Certain Terms in Geographic Distribution." Discussed by Dr. Merriam, Professor Ward, and Dr. Gill.

May 28, 1892. *196th Meeting.*

The President in the chair and 23 persons present.

The new Constitution and By-Laws, after a second reading, were adopted by the Society.

COMMUNICATIONS.

Theodore Gill: "On the Super-Family Chætodontoidea."

C. Hart Merriam: "The Plants of the Pribilof Islands."[3] Discussed by Dr. Gill, Professor Riley, Mr. Coville, and Dr. Merriam.

C. Hart Merriam: "Coon Cave, Missouri." Discussed by Mr. McGee, Dr. Gill, Professor Riley, and Dr. Merriam.

June 11, 1892. *197th Meeting.*

The President in the chair and about 30 persons present.

COMMUNICATIONS.

C. Hart Merriam: "The Southern Fur-Seal (*Arctocephalus*) at Guadalupe Island."[4] Discussed by Dr. Gill and Dr. Merriam.

Frederick V. Coville: "Uses of Plants Among the Panamint

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[1] Description of a new Prairie Dog (*Cynomys mexicanus*) from Mexico. Proc. Biol. Soc. Wash., vol. vii, July 27, 1892, pp. 157, 158.

[2] Third List of Additions to the Flora of Washington, D. C. Proc. Biol. Soc. Wash., vol. vii, June 10, 1892, pp. 105–132.

[3] Plants of the Pribilof Islands, Bering Sea. Proc. Biol. Soc. Wash., vol. vii, July 7, 1892, pp. 133–150.

[4] The Fur-Seal of Guadalupe Island, off Lower California. Fur-Seal Arbitration, Appendix to the Case of the United States, vol. i, Sept., 1892, p. 586.

Indians."[1] Discussed by Dr. ERWIN F. SMITH, Professor RILEY, and Mr. COVILLE.

J. M. HOLZINGER: "On *Amarantus crassipes*."[2]

C. HART MERRIAM: "The Death Valley Expedition," an exhibition of lantern views. Discussed by Dr. ERWIN F. SMITH, Mr. GILBERT, Dr. GILL, Mr. VAN DEMAN, and Mr. COVILLE.

October 22, 1892. *198th Meeting.*

The PRESIDENT in the chair and 35 persons present.

COMMUNICATIONS.

FREDERICK V. COVILLE: "The Present Status of Botanical Nomenclature."

GEORGE VASEY: "Report on the Botanical Congress at Genoa."

G. B. SUDWORTH: "Some Controversial Points in Botanical Nomenclature" Discussed, together with the two preceding papers, by Dr. MERRIAM, Mr. FERNOW, Dr. GILL, and Dr. DALL.

LESTER F. WARD: "Discovery of Fossil Plants in the Potomac Formation, at the New Reservoir, Washington, D. C., and at Mount Vernon."

LESTER F. WARD: "Discovery of a Second Specimen of Saul's Oak, *Quercus primus* × *alba*."

November 5, 1892. *199th Meeting.*

The PRESIDENT (and Professor RILEY) in the chair and 26 persons present.

COMMUNICATIONS.

C. HART MERRIAM: "The Fauna and Flora of Roan Mountain, North Carolina."[3] Discussed by Professor COPE, Professor CHICKERING, Mr. GILBERT, Mr. FERNOW, Mr. VAN DEMAN, Dr. VASEY, Mr. SUDWORTH, Mr. HASBROUCK, Dr. GILL, and Dr. MERRIAM.

C. V. RILEY: "Pea and Bean Weevils."[4] Discussed by Mr. HOWARD, Mr. FERNOW, Dr. MERRIAM, Dr. HORN, and Professor RILEY.

[1] The Panamint Indians of California. The American Anthropologist, vol. v, October, 1892, pp. 351–361, with plate.

[2] On *Amarantus crassipes*. The Botanical Gazette, vol. xvii, August, 1892, pp. 254, 255, with plate xvii.

[3] In part in Proc. Biol. Soc. Wash., vol. vii, Dec. 22, 1892, pp. 175–177.

[4] Insect Life, vol. v, No. 1, 1892, pp. 27–33.

VERNON BAILEY: "The Influence of the Cross Timbers on the Fauna of Texas." Discussed by Mr. VAN DEMAN, Dr. MERRIAM, Professor WARD, and Professor COPE.

November 19, 1892. *200th Meeting.*

The PRESIDENT in the chair and 24 persons present.

COMMUNICATIONS.

THEOBALD SMITH: "On Certain Minute Bodies (Parasitic?) Within the Red Blood Corpuscles."[1] Discussed by Dr. STILES, Dr. REYBURN, and Dr. ERWIN F. SMITH.

C. W. STILES: "The Topographical Relations of the Excretory Canals of Cestodes."[2] Discussed by Dr. DALL and Dr. STILES.

DAVID WHITE: "A New Walchia from New Mexico." Discussed by Professor WARD.

F. M. WEBSTER (read by the Recording Secretary): "Some Entomological Factors in the Problem of Country Fences."[3]

F. V. COVILLE: "Comparative Values of Plants in Determining Floral Zones." Discussed by Dr. MERRIAM.

December 3, 1892. *201st Meeting.*

The PRESIDENT in the chair and 26 persons present.

COMMUNICATIONS.

B. W. EVERMANN: "The Cruise of the U. S. Fish Commission Steamer *Albatross* in Alaskan Waters in 1892." Discussed by Dr. MERRIAM, Dr. GILL, Dr. DALL, Mr. TOWNSEND, and Mr. LUCAS.

GEORGE VASEY: "Some New Grasses." Discussed by Mr. DEWEY.

J. N. ROSE: "On the Rediscovery of Certain Rare Plants."

C. HART MERRIAM: "Exhibition of a Complete Series of the Large American Ground Squirrels of the Subgenus *Otospermophilus*." Discussed by Dr. GILL, Mr. COVILLE, and Dr. MERRIAM.

B. E. FERNOW: "The Mathematics of Forest Growth."

[1] Theobald Smith and F. L. Kilborne: Investigations into the nature, causation, and prevention of Texas or Southern cattle fever. Bull. No. 1, Bureau of Animal Industry, U. S. Dept. Agriculture, 1893, p. 68.

[2] Bemerkungen über Parasiten 17. Ueber die topographische Anatomie des Gefäss systems in der Familie Taeniadæ; Centralblatt für Bakteriologie und Parasitenkunde, vol. xiii, 1893, p. —, figs. 1–12.

[3] Some entomological factors in the problem of country fences. Science, vol. xx, Dec. 16, 1892, pp. 337, 338.

December 19, 1892. *202d Meeting.*

The PRESIDENT in the chair and 28 persons present.

COMMUNICATIONS.

B. E. FERNOW: "What Should be the Scope and Object of a Biological Society?" Discussed by Professor SEAMAN, Professor WARD, Mr. TRUE, Mr. LUCAS, Mr. WAITE, Dr. ERWIN F. SMITH, Professor RILEY, Professor DORAN, Mr. FAIRCHILD, Mr. HOWARD, Dr. DALL, Dr. MERRIAM, and Mr. FERNOW.

LESTER F. WARD: "Frost Freaks of the Dittany." Discussed by several members of the Society.

December 31, 1892. *203d Meeting.*

THIRTEENTH ANNUAL MEETING.

The PRESIDENT in the chair and 18 members present.

The reports of the Corresponding Secretary, Recording Secretary, and Treasurer were presented and accepted.

The Society then proceeded to the election of officers for the year 1893.

VOL. VII, PP. 1-64 APRIL, 1892

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

THE GEOGRAPHIC DISTRIBUTION OF LIFE IN NORTH AMERICA WITH SPECIAL REFERENCE TO THE MAMMALIA.*

BY C. HART MERRIAM, M. D.

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*Annual Presidential Address, delivered at the Twelfth Anniversary Meeting of the Biological Society of Washington, February 6, 1892.

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Introductory Remarks.

Nine years ago the Biological Society listened to an address from its distinguished retiring President, Professor Gill, on "The Principles of Zoogeography," or the science of the geographical distribution of animals.* Professor Gill assembled the oceans of the globe, as well as the land areas, into primary divisions or

* Proc. Biological Society of Washington, vol. II, 1884, 1–39.

'zoological realms,' of which he recognized 9 for the land and 5 for the sea. It is not my purpose to discuss the zoological regions of the whole world, but to lay before you some of the facts concerned in the distribution of terrestrial animals and plants in North America with special reference to the number and boundaries of the sub-regions and minor life areas, and to touch upon the causes that have operated in their production.

No phenomenon in the whole realm of nature forced itself earlier upon the notice of man than certain facts of geographic distribution. The daily search for food, the first and principal occupation of savage man, directed his attention to the unequal distribution of animals and plants. He not only noticed that certain kinds were found in rivers, ponds, or the sea, and others on land, and that some terrestrial kinds were never seen except in forests, while others were as exclusively restricted to open prairies, but he observed further, when his excursions were extended to more distant localities or from the valleys and plains to the summits of neighboring mountains, that unfamiliar fruits and insects and birds and mammals were met with, while those he formerly knew disappeared.

Thus primeval man, and in truth the ancestors of primeval man, learned by observation the great fact of geographic distribution, the fact that particular kinds of animals and plants are not uniformly diffused over the earth, but are restricted to more or less circumscribed areas.

It will be observed that two classes of cases are here referred to, namely, (1) cases in which in the same general region certain species are restricted to swamps or lowlands, while others are confined to dense forests or rocky hillsides—differences of *station*, and (2) cases in which, regardless of *local* peculiarities, a general change takes place in the fauna and flora in passing from one region to another, or from low valleys or plains to high mountains—*geographic* differences. The latter class only is here considered.

Every intelligent schoolboy knows that elephants, lions, giraffes and chimpanzees inhabit Africa; that orangs and flying lemurs live in Borneo; kangaroos in Australia; the apteryx in New Zealand; the Royal Bengal tiger in India; llamas, chinchillas and sloths in South America; the yak in the high table lands of Thibet, and so on. In accordance with these facts naturalists long ago began to divide the surface of the globe into

zoological and botanical regions irrespective of the long recognized geographic and political divisions.* It was found that different degrees of relationship exist between the indigenous animals and plants of different countries, and that as a rule the more remote and isolated the region and the earlier in geologic time its separation took place, the more distinct were its inhabitants from those of other regions. Each of the larger islands lying near the equator and the continental masses of the southern hemisphere were found to possess not only peculiar species and genera, but even families and orders not found elsewhere; and it was discovered that insular areas of considerable magnitude that have had no land connection with other areas since very early times possess faunas and floras remarkable for the antiquity of their dominant types. In Australia, the most disconnected of all the continents, the entire mammalian fauna, though wonderfully diversified in appearance and habits, belongs to the primitive orders of monotremes and marsupials, whose best known representatives are the duck-billed platypus and the kangaroo. In the latter group Australia and neighboring islands contain no less than six families not found in any other part of the world.

Madagascar is the exclusive home of the remarkable aye-aye (*Chiromys*) and *Cryptoprocta*, the latter believed to be intermediate between the cats and civets.

Tropical America is alone in the possession of true ant-eaters (*Myrmecophagidæ*), sloths (*Bradypodidæ*), marmosets (*Hapalidæ*), armadillos (*Dasypodidæ*) and agouties (*Dasyproctidæ*).

Africa is the home of many groups not known elsewhere. Among them are the giraffe, hippopotamus, *Orycteropus*, elephant shrews (*Macroscelididæ*), *Potomogale*, and *Chrysochloridæ*.

Besides this class of cases, in which particular groups are restricted to particular countries, there is another class, in which the living representatives of single groups exist in isolated colonies in widely separated parts of the world. Illustrations of this kind are furnished by the tapirs, which inhabit tropical America and the Malay Peninsula, but do not exist in intermediate lands; by the family *Camelidæ*, represented in South America by the llamas and in parts of Eurasia by the true camels; and by a group

*Among the many distinguished naturalists who have contributed to the literature of the subject may be mentioned Humboldt, Bonpland, Buffon, De Candolle, Schouw, Engler, Agassiz, Baird, Asa Gray, Grisebach, Huxley, Gill, Allen, Wallace, and Packard.

of insectivorous mammals in which all the genera but one are restricted to Madagascar, the one exception (*Solenodon*) living in Cuba and Haiti. Examples of this sort are known as cases of *discontinuous* distribution, and indicate that the ancestors of the animals in question formerly inhabited a vast extent of country; that some sort of land connection, however indirect, existed between the colonies now so widely separated, and that the surviving descendants of these groups are probably approaching extinction.

The examples thus far cited relate to the disconnected land areas in the neighborhood of the equator or in the southern hemisphere, and their explanation is to be sought in the history of the past. In the northern hemisphere animals and plants in general have a much more extended distribution than in the southern, the majority of the larger groups being common to North America, Europe, and Asia, and the limits of their distribution are encountered in traveling in a north and south direction and are evidently the result of causes now in operation. It is to this class of cases as presented on the North American continent that your attention is invited this evening.

In passing from the tropics to the Arctic pole on the eastern side of America a number of distinct zones are crossed, the most conspicuous features of which are well known. In the plant world the palms, mangroves, mahogany, mastic, Jamaica dogwood, and cassias of the tropical coast districts are succeeded by the magnolias, pawpaws, sweet-gums, hackberries, and persimmons of the Southern States. These give place gradually to the oaks, chestnuts, and hickories of the Middle States, and the latter to the groves of aspen, maple, and beech which reach the southern edge of the great coniferous forest of the north—a forest of spruces and firs that stretches completely across the continent from Labrador to Alaska. Beyond this forest is a treeless expanse whose distant shores are bathed in the icy waters of the Arctic Ocean.

Concurrently with these changes in vegetation from the south northward occur equally marked differences in the mammals, birds, reptiles, and insects. Among mammals the tapirs, monkeys, armadillos, nasuas, peccaries, and opossums of Central America and Mexico are replaced to the northward by woodrats, marmots, chipmunks, foxes, rabbits, short-tailed field-mice of several genera, shrews, wild-cats, lynxes, short-tailed porcu-

pines, elk, moose, reindeer, sables, fishers, wolverines, lemmings, musk oxen, and polar bears.

The trogons, saw-bills, parrots, cotingas and other birds of tropical America give place in turn to the cardinals, blue grosbeaks, mocking birds, tufted tits, and gnatcatchers of the Southern States; the chewink, indigo bird, tanager, bluebird, and robin of the Middle and Northern States; the Canada jays, crossbills, white-throated sparrows, and hawk owls of the northern coniferous forests, and the ptarmigans, snowy owls, and snowflakes of the Arctic circle.

Historical Synopsis of Faunal and Floral Divisions Proposed for North America.

The recognition of the above-mentioned facts early led to attempts to divide the surface of the land into faunal and floral regions or zones, and no less than 56 authors have proposed such divisions for North America. Of these, 31 were zoologists and 25 botanists. Of the zoologists, 10 aimed to show the distribution of animals in general, 8 of birds, 4 of terrestrial mollusks, 3 of mammals, 1 of reptiles and batrachians, and 4 of insects. Of the botanists, 22 aimed to show the distribution of plants in general and 3 of forest trees.

Of the writers who attempted to indicate the life areas of the New World prior to 1850, 68 percent were botanists, while during the next twenty years (1850–1870), 65 percent were zoologists. This striking oscillation of the biologic pendulum, first toward botany and then toward zoology, may be attributed in part at least to the influence of two great minds—Humboldt and Agassiz. Humboldt laid the corner-stone of the philosophic study of plant geography in 1805. Stimulated by his example and writings, botanists led the way and were almost the only occupants of the field until the middle of the present century, when the influence of the elder Agassiz gained the ascendency and the botanists were replaced by zoologists, who have been in the lead ever since.

The accompanying table shows the various authors referred to, the dates of the earliest publication of their divisions, the branch of biology on which their conclusions were based, and states whether or not their articles were accompanied by maps.

Latreille	1817	Insects	No map
De Candolle (Aug.)	1820	Plants	No map
Schouw	1822	Plants	Map
Martius	1824–'26	Plants	Map
Minding	1829	Mammals	No map
Pickering	1830	Plants	Map
Lesson	1831	Birds	No map
De Candolle (Alph.)	1835	Plants	No map
Meyen	1836	Plants	No map
Pompper	1841	Animals	No map
Berghaus	1838	Plants	Map
Martens and Galeotti	1842	Plants	No map
Hinds	1843	Plants	No map
Frankenheim	1843	Plants	No map
Wagner	1844	Mammals	Map
Richard and Galeotti	1844	Plants	No map
Binney (A.)	1851	Mollusks	No map
Richardson	1851	Plants	No map
Schmarda	1853	Animals	Map
Agassiz	1854	Animals	Map
Gray	1856	Plants	No map
Woodward	1856	Mollusks	Map
Sclater	1858	Birds	No map
Le Conte	1859	Insects	Map
Cooper	1859	Forests	Map
Hooker	1861	Plants	Map
Binney (W. G.)	1863	Mollusks	Map
Verrill	1863	Birds	No map
Baird	1866	Birds	No map
Murray	1866	Mammals	Map
Grisebach	1866	Plants	Map
Huxley	1868	Animals	Map
Brown	1870	Forests	Map
Allen	1871	Animals	No map
Blyth	1871	Animals	No map
Cope	1873	Repts. and batrchs.	Map
Porter	1874	Plants	Map
Scudder	1874	Insects	Map
Wallace	1876	Animals	Map
Dyer	1878	Plants	No map
Engler	1882	Plants	Map
Packard	1883	Animals	Map
Jordan	1883	Mollusks	Map
Sargent	1884	Forests	Map
Drude	1884	Plants	Map
Hartlaub	1886	Birds	Map
Reichenow	1887	Birds	Map
Heilprin	1887	Animals	Map

Hemsley	1887	Plants	Map
Brendel	1887	Plants	No map
Nelson	1887	Birds	No map
Schwarz	1888	Insects	No map
Bessey	1888	Plants	No map
Ridgway	1889	Birds	No map
Merriam	1890	Animals and plants	Map
Keeler	1891	Birds	Map

The principal bio-geographic divisions that have been recognized by a large number of writers, and as a rule have been proposed independently and under different names, resulting from the study of different groups, are described in the following synopses, each of which may be regarded as a chronologic synonymy of the region to which it refers.

Arctic Division (Above Limit of Trees).

An Arctic circumpolar division north of the limit of tree growth was recognized as a distinct region by European writers long before the earliest attempts were made to map the faunal and floral areas of North America.* Hence the following table is necessarily incomplete, since it shows only the extent to which this zone has been recognized by those who have actually defined faunal and floral areas in North America.

Date	*Author*	*Name given to region*	*Study based on*	*Rank*
1820	De Candolle	Hyperboreal Region	Plants	1
1822	Schouw	Realm of Mosses and Saxifrages.	Plants	1
1830	Pickering	Arctic Region	Plants	1
1831	Lesson	Arctic Region	Birds	1
1835	De Candolle	Arctic Region	Plants	1
1836	Meyen	Polar Zone	Plants	1
1838	Berghaus	Realm of Mosses and Saxifrages.	Plants	1
1843	Hinds	Greenland Region	Plants	1
1844	Wagner	Polar Province	Mammals	2

*This region, however, is not universally recognized. Wallace and a few others refuse to accept it. Agassiz, Allen, and most botanical writers, on the other hand, regard it as one of the best defined of the primary divisions. An important recent treatise on the subject, from the standpoint of the distribution of mammals, is the following: "*Die arktische Subregion—Ein Beitrag zur geographischen Verbreitung der Thiere*," by Dr. August Brauer (Zoologische Jahrbucher, Abth. fur. Syst. III, Jan., 1888, 189–308, taf. VIII).

Date	Author	Name given to region	Study based on	Rank
1853	Schmarda	Barren Grounds.....	Animals.....	2
1854	Agassiz.....	Arctic Realm	Animals.....	1
1856	Woodward ...	Region of Saxifrages and Mosses.	Mollusks.....	1
1858	Cooper.....	Arctic Province.....	Plants.....	1
1866	Grisebach	Arctic-Alpine Region...	Plants.....	1
1870	Brown	Treeless or Eskimo Province.	Forests.....	1
1871	Allen	Arctic Realm.....	Animals.....	1
1875	Cope.....	Arctic Realm.....	Animals.....	1
1878	Dyer.....	Arctic-Alpine Flora	Plants.....	2
1882	Engler	Arctic Region.....	Plants.....	2
1883	Packard.....	Arctic Realm.....	Animals.....	1
1883	Jordan	Arctic Province.....	Mollusks.....	2
1884	Drude.....	Arctic District	Plants.....	2
1887	Brendel.....	Arctic-Alpine Division..	Plants.....	1
1887	Reichenow....	Arctic Zone.....	Birds.....	1
1887	Nelson	Arctic District (Alaskan).	Birds.....	1
1888	Brauer	Arctic Subregion.....	Mammals	2
1890	Merriam.....	Arctic Region.....	Animals and plants.	2

Boreal Division.

This heading is intended to cover the zone of coniferous forests extending across the continent south of the *Arctic Realm*. While its northern boundary is fixed at the limit of trees, its southern border has been variously placed by different writers. Schouw did not recognize it at all, but carried his great forest region down to latitude 36°, where the true southern district begins. Berghaus, who in other respects followed Schouw, divided this great region into two parts, the northernmost of which he named the '*Realm of Conifers*,' placing its southern limit in the east at about latitude 47°. Hinds, Agassiz, Woodward, Verrill, and Drude speak of it as the '*Canadian*' Region. Its southern limit is here extended to include the '*Canadian Fauna*' of recent zoological writers.

The extent to which this zone has been recognized will appear from the following table:

Date	Author	Name given to region	Study based on	Rank
1830	Pickering	Canadian Flora.....	Plants.....	2
1838	Berghaus.....	Realm of Conifers.....	Plants.....	1
1843	Hinds.....	Canadian Region.....	Plants.....	1
1853	Schmarda	Region of Coniferous Forests.	Animals.....	2

Date	*Author*	*Name given to region*	*Study based on*	*Rank*
1854	Agassiz	Canadian Fauna	Animals	2
1856	Woodward	Canadian Province	Mollusks	1
1856	Gray	Middle and Northern Wooded District.	Plants	(?)
1859	Le Conte	Northern Province	Insects	2
1859	Cooper	Lacustrian Province	Forests	1
1863	Verrill	Canadian Fauna	Birds	1
1863	Binney	Northern Region	Mollusks	2
1870	Brown	Lacustrian Province	Forests	1
1871	Allen	Hudsonian and Canadian Faunas.	Animals	3
1882	Engler	Region of Conifers	Plants	2
1883	Packard	Boreal Province	Animals	1
1884	Sargent	Northern Forest	Forests	2
1884	Drude	Canadian District	Plants	2
1890	Merriam	Boreal Region	Animals and plants.	2

Atlantic, Central, and Pacific Divisions of Temperate North America.

It has been the custom of recent writers to divide the broad middle zone of North America (most of which lies within the United States) into three main divisions—*Atlantic* or *Eastern*, stretching from the Atlantic Ocean to the eastern border of the plains; *Central*, from the plains to the Sierra Nevada; and *Pacific*, from the Sierra to the Pacific Ocean.* These regions were proposed as early as 1854 by the elder Agassiz, who however divided the Eastern or Atlantic district into two regions of equal rank—*Alleghanian* and *Louisianian*, or faunas of the Middle and the Southern States. In this respect he has been followed by Cope. Other authors, including Le Conte, Baird, and Allen, regard the southern district as only a subdivision of the Eastern region. Agassiz named the Central region the '*Table-land or Rocky Mountain Fauna*' and the Pacific the '*Californian Fauna*.'

This arrangement of the United States into three provinces has been followed in the main by Le Conte (1859), W. G. Binney (1863), Baird (1866), Cope (1873), Grisebach (1875), Wallace

*These divisions must not be confounded with those of Amos Binney (published in 1851) bearing the same names, for Binney's Atlantic region lay between the Atlantic and Alleghanies, his Central region between the Alleghanies and the Rocky mountains, and his Pacific region between the Rocky mountains and the Pacific. Woodward's divisions (1856) are essentially those of Amos Binney.

(1876), Allen (1878), Packard (1883), Jordan (1883), Hartlaub & Newton (1886), and Heilprin (1887).

The three divisions will be considered separately.

Atlantic or Eastern Forest Region.—Many writers have recognized an eastern forest region stretching from the plains to the Atlantic and in a general way from the boreal or coniferous forests of the north to the alluvial lands of the South Atlantic and Gulf States; but its northern and southern limits have been by no means agreed upon. Schouw defined these boundaries as the limit of trees on the north and latitude 36° on the south, and named the region Michaux's Realm or *Realm of Asters and Solidagos*. Berghaus retained Schouw's southern boundary, but took off a broad belt on the north, which he named the *Realm of Coniferous Forests*. The resulting northern limit as shown on his map (1838) agrees closely with that adopted by such recent writers as Wallace (1876), Allen (1878), Packard (1883), and Heilprin (1887), all of whom, on the other hand, carry its southern boundary south to the Gulf of Mexico, thus making it coextensive with the *Atlantic* or *Eastern Province* already referred to.

Several early writers, among whom Schouw and Berghaus were prominent, recognized this region in the east, but knew nothing of the great interior plains, and consequently spoke of it as extending all the way to the Rocky mountains.

The extent to which this Eastern Forest region has been recognized, together with the approximate north and south boundaries assigned it, will appear from the following table:

NOTE.—In the columns showing limit on the north and south the following abbreviations are used: L. T. = northern limit of trees; C. F. = northern coniferous forests; A. = Austroriparian or Louisianian region; G. = Gulf of Mexico.

Date	*Author*	*Name given to region*	*Limit on the North*	*Limit on the South*	*Based on*	*Rank*
1822	Schouw	Asters and Solidagos.	L. T.	A.	Plants	1
1830	Pickering	Flora of United States	C. F.	G.	Plants	2
1838	Berghaus	Asters and Solidagos.	C. F.	A.	Plants	1
1843	Hinds	Iroquoian	C. F.	G.	Plants	1
1848	Frankenheim	New England	C. F.	A.	Plants	2
1854	Agassiz	Alleghanian	C. F.	A.	Animals	2
1856	Gray	Northern States	(?)	A.	Plants	1
1859	Le Conte	Eastern	(?)	G.	Insects	1
1859	Cooper	Appalachian	C. F.	G.	Forests	1

Date	*Author*	*Name given to region*	*Limit on the North*	*Limit on the South*	*Based on*	*Rank*
1863	Verrill	Alleghanian	C. F.	A.	Birds	1
1863	Binney (W. G.)	Interior	C. F.	A.	Mollusks	2
1866	Baird	Eastern	C. F.	G.	Birds	1
1866	Grisebach	Forest	L. T.	G.	Plants	1
1870	Brown	Appalachian	C. F.	G.	Forests	1
1871	Allen	Eastern	C. F.	G.	Animals	2
1873	Cope	Eastern	(?)	A.	Animals	2
1874	Porter	Forest	C. F.	G.	Plants	1
1876	Wallace	Alleghanian	C. F.	G.	Animals	2
1882	Engler	Appalachian Province	C. F.	G.	Plants	3
1883	Packard	Eastern	C. F.	G.	Animals	1
1883	Jordan	Atlantic Region	C. F.	G.	Mollusks	3
1884	Sargent	Deciduous Forests	C. F.	A.	Forests	2
1884	Drude	Virginian	C. F.	G.	Plants	2
1886	Hartlaub	Alleghanian	C. F.	G.	Birds	2
1887	Heilprin	Alleghanian	C. F.	G.	Animals	2
1887	Brendel	Mixed Forest	C. F.	G.	Plants	2
1889	Ridgway	Eastern Province	(?)	G.	Birds	1

Central or Middle Division.—This division extends from the eastern border of the great plains to the Sierra Nevada and Cascade Mountains. It was first proposed by Agassiz in 1854, under the name '*Table-land Fauna or Fauna of the Rocky Mountains.*'

The extent to which it has been recognized will appear from the following table:

Date	*Author*	*Name given to region*	*Based on*	*Rank*
1854	Agassiz	Table-land Fauna	Animals	3
1859	Le Conte	Central District	Insects	1
1863	Binney (W. G.)	Central Province	Mollusks	1
1866	Baird	Middle Province	Birds	1
1866	Grisebach	Prairie Region	Plants	1
1873	Cope	Central Region	Repts. and batrs.	2
1876	Wallace	Rocky Mountain Subregion.	Animals	2
1878	Allen	Middle Province	Animals	2
1881	Gray	Central Province	Plants	1
1883	Packard	Central Province	Animals	1
1883	Jordan	Central Region	Mollusks	3
1884	Drude	Montana District	Plants	2
1886	Hartlaub	Rocky Mountain Region	Birds	2
1887	Heilprin	Rocky Mountain Subregion.	Animals	2
1887	Brendel	Prairie Flora	Plants	1
1889	Ridgway	Rocky Mountain or Middle District.	Birds	2

Pacific or California Division.—This name has been very generally applied to the Pacific coast region of the United States. It was first recognized by the botanist De Candolle in 1820. Pickering, in 1830, named it the *Californian Flora*, but, knowing little or nothing of the Sierra Nevada and believing the Rocky Mountains to be the only mountain system of importance in North America, extended its eastern boundary to that range. In this he was followed by the botanist Hinds, in 1843; by the conchologists, Amos Binney, in 1851, and Woodward, in 1856. Agassiz, in 1854, was first to fix its eastern limit at the Sierra Nevada and Cascade mountains, where it has been permitted to rest. Its north and south boundaries have undergone considerable fluctuations.

The extent to which the Pacific or Californian region has been recognized will appear from the following table:*

Date	*Author*	*Name given to region*	*Based on*	*Rank*
1820	De Candolle ..	West Coast of Temperate North America.	Plants.....	1
1830	Pickering.....	Californian Flora	Plants.....	2
1843	Hinds.....	Californian Region.....	Plants.....	1
1848	Frankenheim .	California	Plants.....	2
1851	Binney (A.)...	Pacific Region	Mollusks	1
1854	Agassiz.....	Californian Fauna.....	Animals.....	3
1856	Woodward	Californian Province	Mollusks	1
1859	Le Conte	Western District.....	Insects	1
1859	Cooper	Nevadian Province†.....	Forests.....	1
1863	Binney (W. G.)	Pacific Province.....	Mollusks	1
1866	Baird	Western Province.....	Birds.....	1
1866	Grisebach	Californian Region.....	Plants.....	1
1873	Cope	Pacific Region	Repts. and batrchs.	2
1874	Porter.....	Pacific Region	Plants.....	1
1876	Wallace	Californian Subregion...	Animals.....	2
1878	Allen.....	Western Province.....	Animals.....	2
1883	Packard	Western Province.....	Animals.....	1
1883	Jordan	Pacific Region	Mollusks	3
1884	Drude.....	Californian District	Plants.....	2
1886	Hartlaub	Californian Region.....	Birds.....	2
1887	Heilprin.....	Californian Subregion...	Animals.....	2
1887	Brendel	Californian Flora	Plants.....	1
1889	Ridgway	Pacific District.....	Birds.....	2

* Engler's 'California Coast Province' is not included in this table, because it consists only of the narrow strip of land between the Coast Range and the Pacific.

† Named from the Sierra Nevada—not the State of Nevada.

Austroriparian or Louisianian Division.

(South Atlantic and Gulf States.)

Latreille, as early as 1817, called attention to the difference in the insect fauna of Carolina and Georgia from that of Pennsylvania and New York, and in his division of the earth into circumpolar zones ran the boundary line between these faunas at latitude 36°. The difference in the flora of the South Atlantic and Gulf States from that of the Northern States was recognized by the Danish botanist Schouw as early as 1822 in the '*Realm of Magnolias, or Pursh's Realm*,' which he then proposed for the region between the parallels of 30° and 36° north latitude. Thirty-four years later (in 1856) the northern boundary of the same area was run by America's greatest botanist, Dr. Asa Gray, along the parallel of 36° 30′, only half a degree from Schouw's line. The first zoologist to recognize this region was the elder Binney, who died in 1847. His posthumous work on *Terrestrial Air-Breathing Mollusks*, published in 1851, describes it under the name '*Tertiary Region of the Atlantic Coast and the Gulf of Mexico*.' The elder Agassiz recognized it in 1854 as one of his seven primary regions, naming it the *Louisianian Fauna*. Later writers, except Cope, have considered it a subdivision of the Eastern Forest region. Cope restored it to primary rank in 1873 and named it the *Austroriparian Region*.

The extent to which this region has been recognized will appear from the following table:

Date	*Author*	*Name given to region*	*Based on*	*Rank*
1817	Latreille.....	Supertropical Climate...	Insects	1
1822	Schouw	Realm of Magnolias....	Plants	1
1836	Meyen	Subtropical Zone.....	Plants.....	1
1837	Martius	Mississippi-Floridian Realm.	Plants.....	1
1838	Berghaus	Realm of Magnolias .	Plants.....	1
1851	Binney (A.)...	Tertiary Region of Atlantic and Gulf coasts.	Mollusks	2
1853	Schmarda	Middle American Realm.	Animals.....	1
1854	Agassiz.....	Louisianian Fauna	Animals.....	3
1856	Gray	Southern States.....	Plants.....	1
1859	Le Conte.....	Southern Province.....	Insects	2
1859	Cooper	Carolinian and Mississippian.	Forests	2
1863	Binney (W.G.)	Southern Region.....	Mollusks	2
1866	Baird	Southern Subdivision...	Birds.....	2
1866	Verrill	Louisianian Fauna.....	Birds.....	2
1871	Allen	Louisianian Fauna.....	Birds.....	3

Date	Author	Name given to region	Based on	Rank
1873	Cope	Austroriparian Region..	Repts. and batrchs.	2
1874	Porter	Southern District	Plants	2
1883	Jordan	Southern District	Mollusks	4
1884	Sargent	Coast Pine Region	Forests	2
1890	Merriam	Austroriparian Region..	Animals and plants.	2

Sonoran Division.

The term '*Sonoran Region*' has been applied by Cope and others to an important life area which enters the southwestern part of the United States from the table-land of Mexico. It was first recognized by a botanist, Richard Brinsley Hinds, R. N., surgeon to H. M. S. *Sulphur*, who published a description of it in 1843 under the name '*The Chihuahua Region*.' He defined it as extending south to the tropic, west to the Gulf of California and the Colorado River, north to the prairie region of the United States, and separated on the east from the Gulf of Mexico by a northward extension of the Central American region along the lowlands bordering the coast. Professor Baird (in 1866) stated that along the valleys of the Rio Grande and Gila the fauna of the Central Province "is greatly mixed up with the peculiar fauna of northern Mexico, which, as far as its summer birds indicate, is almost entitled to be considered as a fourth main province."

The extent to which this region has been recognized will appear from the following table:

Date	Author	Name given to region	Based on	Rank
1843	Hinds	Chihuahuan	Plants	1
1859	Le Conte	Southwestern and Southsouthwestern Provinces.	Insects	2
1859	Cooper	Arizonian Region	Forests	2
1861	Cooper	Arizonian and Chihuahuan Regions.	Forests	2
1866	Baird	[No name given]	Birds	2
1870	Brown	New Mexican Region	Forests	2
1873	Cope	Sonoran	Repts. and batrchs.	2
1874	Porter	Cactus Region	Plants	1
1878	Dyer	Mexico-Californian Flora	Plants	2
1882	Engler	Aztec Province	Plants	3
1884	Sargent	Mexican Forest Region	Forests	1
1884	Drude	North Mexico and Texas District.	Plants	2
1887	Heilprin	Sonoran Transition Region.	Animals	(?)
1890	Merriam	Sonoran Province	Animals and plants.	1

Peninsula of Lower California.

That the fauna and flora of the peninsula of Lower California, or any part of it, differs radically from that of the state of California immediately on the north was pointed out almost simultaneously by Baird and Le Conte in 1859. Baird stated that the fauna of its southern extremity, as determined by collections of its mammals, birds, and reptiles, "is almost identical with that of the Gila River, and to a certain extent with that of the Rio Grande," but differs wholly from that of Upper California. In accordance with these facts he afterward (in 1866) made Lower California a subdivision of the Central Province. Later in the same year (1859) Le Conte stated that a few species of insects from Cape St. Lucas, "though all new, indicate a greater resemblance to the fauna of the Lower Colorado than to that of maritime California; this province may therefore be found eventually to belong to the interior district."

Cooper (in 1861) proposed the name *Uchitan* for the Forest Flora of Lower California, and regarded it as a subdivision of his Nevadian (= Californian) Province. Grisebach also, in mapping the plant regions of the world in 1866, included the peninsula in his Californian Region, but afterward (in 1872) transferred it to the interior or prairie region.

Cope, in 1873, raised Lower California to primary rank, basing his action on a study of its reptiles and batrachians. Wallace, in 1876, placed it in the Central Province without subdivision. Packard, in 1883, followed Baird and Grisebach in regarding the southern part of the peninsula as a subdivision of the Central Province, while the northern part was assigned to the Pacific Province. Drude, in 1884, divided it transversely in two nearly equal plant areas, placing the northern half in his '*North Mexico and Texas District*,' and the southern half in his tropical '*Mexican District*.' Hartlaub and Newton, in 1886, placed the entire peninsula in their *Mexican Region*, and Heilprin, in 1887, in his *Sonoran Transition Region*.

The way in which Lower California has been regarded by different writers is shown in the following table:*

* Note.—In the few cases in which the peninsula has been divided, the assignment here given relates to the southern extremity.

Date	Author	How regarded	Study based on	Rank
1837	Martius	As part of his Mexican Extra-tropical Realm.	Plants	0
1838	Berghaus	As part of his Mexican Realm ('Jacquin's Realm').	Plants	0
1843	Hinds	As part of his Californian Region.	Plants	0
1845	Berghaus	As part of his Tropical Province.	Mammals	0
1854	Agassiz	As part of his Californian Fauna.	Animals	0
1856	Woodward	As part of his Californian Province.	Mollusks	0
1859	Baird	As a subdivision of his Middle Province.	Birds	2
1859	Le Conte	As part of his Central District.	Insects	0
1861	Cooper	As a subdivision of his Nevadian [= Californian] Province.	Forests	2
1866	Grisebach	As part of his Californian Region.	Plants	0
1870	Brown	As part of his Colorado Desert District.	Forests	0
1872	Grisebach	As part of his Prairie Region	Plants	0
1873	Cope	As an independent region	Reptiles and batrachians.	2
1876	Wallace	As part of his Californian Subregion.	Animals	0
1882	Engler	As part of his Aztec Province	Plants	0
1883	Packard	As part of his Central Province.	Animals	0
1884	Drude	As part of his Mexican District.	Plants	0
1886	Hartlaub	As part of his Mexican Region.	Birds	0
1887	Heilprin	As part of his Sonoran Transition Region.	Animals	0
1890	Merriam	As a division of his Sonoran Province.	Animals and plants.	2

Southern Florida.

The large number of tropical forms of life inhabiting southern Florida early led to its separation from the rest of the Atlantic region by writers on the distribution of animals and plants. Lesson (in 1831) placed it along with Mexico in his South Temperate Zone. Hinds (in 1843), recognizing its Antillean affinities, placed the southern extremity of the peninsula (south of latitude 27°) in his *West India Region*.

The extent to which southern Florida has been recognized as faunally and florally distinct from the rest of the United States is shown in the following table:

Date	*Author*	*Name given to region*	*Based on*	*Rank*
1831	Lesson	[Florida division of South Temperate Zone.]	Birds.....	0
1843	Hinds.....	[Florida division of West India Region.]	Plants.....	0
1851	Binney (A.) ..	Peninsula of Florida.....	Mollusks ...	2
1858	Cooper	Floridian Region.....	Forests.....	2
1859	Le Conte.....	Subtropical Province.....	Insects	2
1866	Baird	[Florida division of Atlantic Region.]	Birds.....	3
1866	Verrill	[Florida division of West Indian Region.]	Birds.....	0
1870	Brown	Florida Subregion	Forests.....	2
1871	Allen	Floridian Fauna	Birds.....	3
1873	Cope.....	Floridian District	Reptiles and batrachians.	3
1874	Porter.....	Florida Region	Plants.....	1
1883	Packard.....	[Florida division of Antillean Region.]	Animals....	0
1883	Jordan	[Florida division of Neotropical Province.]	Mollusks ...	0
1884	Sargent.....	Semi-tropical forest of Florida.	Forests.....	2
1887	Drude.....	[Florida division of Antillean Region.]	Plants.....	0
1887	Reichenow ...	[Florida division of South American Region.]	Birds.....	0
1887	Brendel	South Florida [Antillean] ...	Plants.....	1
1888	Schwarz.....	[Florida division of Antillean Region.]	Insects	0
1890	Merriam	[Florida division of Antillean Subregion.]	Animals and plants.	3

Antillean Division.

The fauna and flora of the West Indies have been variously interpreted by different writers, some placing the region in South America, others in Mexico, and others still raising it to independent rank.

In 1822 Schouw, in mapping the plant areas of the world, placed it in his '*Jacquin's Realm or Realm of Cactuses and Peppers*,' Subsequently, however (in 1833), he gave it independent primary rank, naming it '*Swartz's Realm*.' Martius, in 1837, was first to bestow the name '*Antillean Realm*' upon this region, which he regarded as a division of primary rank, comprising the West Indies and adjacent coasts of South and Central America. The same arrangement was retained in his lectures on Floral Realms in 1865.

The way in which the West Indies have been regarded by different writers is shown in the following table:

Date	*Author*	*How regarded*	*Based on*	*Rank*
1820	De Candolle..	As an independent region.....	Plants.....	1
1822	Schouw	As part of his Realm of Cactuses and Peppers [Mexican].	Plants.....	0
1830	Pickering.....	As part of his American Intertropical Region.	Plants.....	0
1831	Lesson	As part of his Equatorial Zone.	Birds.....	0
1833	Schouw	As an independent realm (Swartz's Realm).	Plants.....	1
1835	De Candolle..	As an independent region....	Plants.....	1
1837	Martius	As an independent realm (Antillean Realm).	Plants.....	1
1838	Berghaus	As an independent realm (Swartz's Realm).	Plants.....	1
1841	Pompper	As part of his North Warm Zone.	Animals....	0
1843	Hinds.....	As an independent realm (West India Region).	Plants.....	1
1845	Berghaus	As part of his Tropical Province.	Mammals ..	0
1846	Wagner	As part of his Tropical American Province.	Mammals ..	0
1854	Agassiz.....	As a subdivision of his Central American Region.	Animals....	3
1856	Woodward ...	As an independent province (Antillean Province).	Mollusks ...	1
1858	Sclater	As part of his Neotropical Region.	Birds.....	0
1866	Baird	As a primary region (West Indian Region).	Birds.....	1
1866	Grisebach	As a primary region (West Indian Region).	Plants.....	1
1868	Huxley	As part of his Austro-Columbian Region.	Animals....	0
1870	Brown	As an independent province (Antillean Province).	Forests.....	1
1875	Sclater	As an independent subregion (Antillean Subregion).	Birds.....	2
1876	Wallace	As an independent subregion (Antillean Subregion).	Animals....	2
1882	Engler	As an independent province..	Plants.....	3
1883	Packard.....	As an independent region (Antillean Region).	Animals....	1
1883	Jordan	As part of his Neotropical Province.	Mollusks ...	0
1884	Drude.....	As an independent region (Antillean District).	Plants.....	2

Date	*Author*	*How regarded*	*Based on*	*Rank*
1886	Hartlaub.....	As an independent region (Antillean Region).	Birds.....	2
1887	Heilprin.....	As a subdivision of his Neotropical Region.	Animals....	2
1887	Reichenow...	As part of his South American Region.	Birds.....	0
1890	Merriam.....	As a division of his Tropical Province.	Animals and plants.	2

Northwest Coast Division.

In 1843 Hinds, in mapping the plant regions of the world, proposed a '*Northwest American Region*' for the area west of the Rocky Mountains, north of the Columbia River, and south of latitude 68° north. Agassiz, in his paper on the Zoological regions of the earth (1854), gave the name '*Northwest Coast Fauna*' to essentially the same area (shown on his map as extending along the Pacific from northern California to the base of the Unalaskan peninsula).

In 1859 Le Conte, who based his studies on Coleoptera, spoke of this region as the '*Hyperborean Province*' of the Pacific district; and the same year Cooper, writing of forest regions, described it as the '*Canine Province*.' W. G. Binney, in 1873, mentioned it as the '*Oregonian Division*' of the Pacific Province; Engler, in 1882, as the '*Kaloschen Zone*'; Drude, in 1884, as the '*Columbian District*'; Nelson, in 1887, as the '*Sitkan District*'; Brendel, in 1887, as the '*North Pacific Province*.'

Prairie Division.

A few botanists, influenced by the widely different aspects of nature resulting from the presence or absence of forests, have recognized a 'Prairie Region' as one of the great floral divisions of North America. It was first proposed by Pickering, in 1830. Pickering named it the '*Louisianian Flora*,' and gave its boundaries as the Mississippi on the east and the Rocky Mountains on the west. Hinds described it, in 1843, as "a peculiar tract enclosed by the vast forests of North America." He named it the 'Prairie Region,' and said it extended "from within a hundred miles of the west bank of the Mississippi to the Rocky Mountains, stretching north to 54° north latitude, and again only bounded on the south by the wooded country of the Texas and the Mexican Sea."

Cooper, in his paper on the distribution of forests (in 1859), named it the *Campestrian Province*. It was recognized by Brown in 1870, by Porter in 1874, and by Engler in 1882.

Recapitulation.

It is seen that a number of zoologists and botanists, basing their studies on widely different groups, and as a rule ignorant of the writings of their predecessors, have agreed in the main in the recognition of at least seven (7) life areas in extratropical North America, namely: (1) an *Arctic area* north of the limit of tree growth; (2) a *Boreal transcontinental coniferous forest region;* (3) an *Atlantic or Eastern wooded region* stretching westward from the Atlantic to the Great Plains: (4) a *Central or Middle region*, reaching from the Plains to the Sierra Nevada and Cascade Mountains; (5) a *Pacific or Californian division*, covering the area between the east base of the Sierra and the Pacific ocean; (6) a Louisianian or *Austroriparian division*, comprising the South Atlantic and Gulf States south of latitude 36°: (7) a *Sonoran division*, occupying the high table-land of Mexico and stretching northward over the dry interior far enough to include the southern parts of California, Nevada, Arizona, New Mexico, and Texas.

With or without reference to the above principal divisions, it has been recently the custom of zoologists, particularly ornithologists, to subdivide the eastern United States and Canada into several minor areas or 'faunas,' as follows: (*a*) Floridian; (*b*) Louisianian; (*c*) Carolinian; (*d*) Alleghanian; (*e*) Canadian; (*f*) Hudsonian; and (*g*) Arctic. Of these the Canadian and Hudsonian form a part of the '*Boreal*' region above mentioned, and the Floridian and Louisianian together make up the '*Austroriparian*' division, leaving only the Carolinian and Alleghanian for the so-called 'Eastern Province' to rest on. The true relations of these zones will be explained later.

Life Regions and Zones of North America.

In a communication I had the honor to lay before this Society two years ago (December 4, 1889)* I stated that the Hudsonian

*Since published in my report on the "*Results of a Biological Survey of the San Francisco Mountain Region in Arizona*," N. Am. Fauna, No. 3, September 11, 1890.

and Canadian zones of the East belong to the *Boreal* region and extend completely across the continent, and that the desert areas of the West belong to the Southern or *Sonoran* region. The pine plateau (*Pinus ponderosa*) of Arizona and other parts of the West was "shown to consist of a mixture of Boreal and Sonoran types. * * * In other words, it is *neutral* territory" (North American Fauna, No. 3, September, 1890, p. 20). I remarked further that the Carolinian fauna "is suffused with southern forms, and the Alleghanian seems to be *neutral* ground" (Ibid. p. 18), thus implying that the 'neutral' or pine-plateau zone of Arizona is the western equivalent of the 'Alleghanian Fauna' of the East.

In a subsequent publication (North American Fauna, No. 5, August, 1891) I went a step further, defining the treeless parts of the 'Neutral or Transition Zone,' and characterizing an 'Upper Sonoran Zone' as distinguished from the Lower or True Sonoran; but nothing was said as to the relations of these zones with those long recognized in the East.

The time has now arrived, however, when it is possible to correlate the Sonoran Zones of the West with corresponding zones in the East, as was done two years ago in the case of the Boreal Zones, and as was intimated in the case of the Neutral or Transition Zone. It can now be asserted with some confidence not only that the Transition Zone of the West is the equivalent of the Alleghanian of the East, but also that the Upper Sonoran is the equivalent of the Carolinian, and the Lower Sonoran of the Austroriparian, and that each can be traced completely across the continent. Thus, all the major and minor zones that have been established in the East are found to be uninterruptedly continuous with corresponding zones in the West, though their courses are often tortuous, following the lines of equal temperature during the season of reproduction, which lines conform in a general way to the contours of altitude, rising with increased base-level and falling with increased latitude.

The Boreal Region extends obliquely across the entire continent from New England and Newfoundland to Alaska and British Columbia, and from about latitude 45° north to the Polar Sea, conforming in general direction to the trend of the northern shores of the continent. It recedes to about latitude 54° on the plains of the Saskatchewan, and gives off three long arms or chains of islands, which reach far south along the three great mountain systems of the United States—an eastern arm in the

Alleghanies, a central arm in the Rocky Mountains, and a western arm in the Cascades and Sierra Nevada. The latter at its northern base occupies the entire breadth of the Pacific Coast region from the eastern slope of the mountains to the sea, but in passing southward bifurcates, the main fork following the lofty Cascade and Sierra ranges to about latitude 36°; the other following the coast, gradually losing its distinctive characters and becoming invaded with Sonoran forms until it disappears a little north of San Francisco.

The following genera of mammals belong exclusively to the Boreal Region, none of them ranging south beyond the Transition Zone:

Cervus	Cuniculus
Rangifer	Zapus
Alce	Erethizon
Mazama	Lagomys
Ovibos	Thalarctos
Arctomys	Latax
Aplodontia	Gulo
Evotomys	Mustela
Phenacomys	Neurotrichus (?)
Myodes	Condylura

In addition to the above, the following genera are clearly of Boreal origin, although reaching and in some cases penetrating parts of the Sonoran Region:

Ovis	Vulpes
Bison *	Ursus
Tamias	Lutreola
Castor	Putorius
Arvicola	Sorex
Fiber	

Besides the genera here enumerated, the following subgenera belong to the Boreal Region: *Tamiasciurus* (containing the red or spruce squirrels), *Mynomes* and *Chilotus* (field-mice or voles, of which *Mynomes* reaches south a little beyond the Transition Zone), *Teonoma* (the bushy-tailed wood-rats), and *Neosorex* and *Atophyrax* (subgenera of shrews).

*The faunal position of the genus *Bison* is not so certain as in the case of the other genera here mentioned, though both the American and the European species seem to be of Boreal origin.

The Boreal Region is made up of two principal divisions, both circumpolar: (1) An *Arctic division*, above the limit of tree growth; and (2) A *Boreal Coniferous Forest division*.

Arctic Mammals.

(Found above the limit of trees and all circumpolar.)

A. *Exclusively Arctic.*

Eskimo	*Homo*
Polar bear	*Thalarctos maritimus*
Barren ground bear	*Ursus richardsoni*
Musk ox	*Ovibos moschatus*
Barren ground caribou	*Rangifer grœnlandicus*
Arctic fox	*Vulpes lagopus*
Arctic hare	*Lepus glacialis*
Lemming	*Myodes obensis*
Lemming	*Cuniculus torquatus*
Arctic red-backed mouse	*Evotomys rutilus*
Parry's spermophile	*Spermophilus empetra*

B. *Common to Arctic and Hudsonian.*

Wolverine	*Gulo luscus*
Gray wolf	*Canis griseus*
Ermine	*Putorius erminea*

The *Boreal Coniferous Forest division* may be subdivided into at least two transcontinental zones: (*a*) Hudsonian, and (*b*) Canadian; and a third or 'Timberline Zone' may be differentiated from the Hudsonian proper. In speaking of the divisions of the Boreal Region on high mountains it is customary to add the word *alpine* to the name of the division; thus, *Arctic-alpine*, *Hudsonian-alpine*, and so on.

Mammals of the Boreal Zone.

(The letter *a* indicates that the species is known only from mountains, or is an alpine form.)

Cervus canadensis
Rangifer caribou
Alce americanus
Mazama montana
Ovis canadensis
dalli
Sciuropterus volans sabrinus
Sciurus fremonti
mogollonensis (*a*)
hudsonicus
californicus (*a*)
vancouverensis
richardsoni
douglassi

Tamias cinereicollis (*a*)
obscurus (*a*)
senex (*a*)
speciosus (*a*)
townsendi
umbrinus (*a*)
quadrivittatus (*a*)
amœnus (*a*)
luteiventris (*a*)
borealis
neglectus
Spermophilus lateralis
castanurus (*a*)
chrysodeirus (*a*)
cinerascens
armatus (*a*)
beldingi (*a*)
empetra
kodiacensis
columbianus
Arctomys caligatus (*a*)
dacota (*a*)
flaviventer (*a*)
Aplodontia major (*a*)
rufa
Sitomys americanus arcticus
austerus
Neotoma cinerea drummondi
Phenacomys borealis
celatus
intermedius
latimanus
longicaudus
orophilus (*a*)
ungava
Evotomys californicus
occidentalis
idahoensis
carolinensis (*a*)
dawsoni
galei (*a*)
gapperi
brevicaudus
Arvicola alticolus (*a*)
Arvicola drummondi
nanus (*a*)
oregonus
mordax
longicaudus
townsendi
macropus
xanthognathus
Myodes obensis
Cuniculus torquatus
Zapus hudsonius
Erethizon dorsatus
epixanthus
Lagomys princeps (*a*)
schisticeps (*a*)
Lepus americanus
bairdii (*a*)
washingtoni
Lynx canadensis
Ursus americanus
horribilis
Putorius culbertsoni
longicauda
Mustela americana
caurina
pennanti
Sorex belli
dobsoni (*a*)
forsteri
idahoensis
monticolus (*a*)
pacificus
richardsoni
sphagnicolus
suckleyi
trowbridgei
vagrans
similis (*a*)
albibarbis
palustris
hydrodromus
Condylura cristata
Vesperugo noctivagans
Atalapha cinerea

The Sonoran Region as a whole stretches across the continent from Atlantic to Pacific, covering nearly the whole country south of latitude 43° and reaching northward on the Great Plains and Great Basin to about latitude 48°. It is invaded from the north by three principal intrusions of Boreal forms along the three great mountain systems already mentioned; while to the southward it occupies the great interior basin of Mexico and extends into the tropics along the highlands of the interior. It covers also the peninsula of Lower California, the southern part of which seems entitled to rank as an independent subdivision.

The following genera belong exclusively to the Sonoran Region (as distinguished from the Boreal), none of them ranging north beyond the Transition Zone. Those preceded by the letter *T* are intrusions from the Tropical Region.

T Didelphis
T Tatusia
T Dicotyles
Reithrodontomys *
Onychomys
Oryzomys
Sigmodon
Geomys
Dipodomys
Perodipus †
Microdipodops
Perognathus
Heteromys
Urocyon
Bassariscus
T Nasua
Conepatus
Spilogale
Notiosorex
Scalops
Corynorhinus
Euderma
Antrozous
Nycticejus
T Molossus
T Nyctinomus
T Otopterus

In addition to the above, the following genera seem to be of Sonoran or austral origin, although reaching and in some cases penetrating a considerable distance into the Boreal region:

* The generic name *Reithrodontomys* was proposed by Giglioli in 1873 (Richerche intorno alla Distribuzione Geografica Generale, Roma, 1873, p. 160), and antedates *Ochetodon* of Coues.

† The generic name *Perodipus* was proposed in 1867 by Fitzinger for the five-toed kangaroo rats (Sitzungsber. math. nat. Classe, K. Akad. Wiss. Wien, LVI, 1867, p. 126), thus antedating by twenty-three years the name *Dipodops* proposed by the writer for the same type in 1890 (North Am. Fauna, No. 3, September, 1890, p. 72). Both generic names were based on *Dipodomys agilis* of Gambel, from Los Angeles, California.

Cariacus	Mephitis
Antilocapra	*T* Felis
Cynomys	Lynx
Sitomys *	Scapanus
Neotoma	Blarina
Thomomys	Atalapha
T Procyon	Vesperugo
Taxidea	Vespertilio

The genera *Sitomys*, *Mephitis*, *Lynx*, *Atalapha*, *Vesperugo*, and *Vespertilio* range well north in the Boreal Zone, where each is represented by a single species. In the Sonoran Zone, on the other hand, these same genera reach their maximum development and are represented by numerous species.

Besides the genera above enumerated, a number of subgenera belong to the Sonoran Region. Among these are *Neosciurus* and *Parasciurus* (subgenera of *Sciurus*), *Xerospermophilus*,† *Ammospermophilus*‡ and *Ictidomys* (subgenera of *Spermophilus*), *Pitymys*, *Pedomys* and *Neofiber* (subgenera of *Arvicola*), and *Chætodipus* (a subgenus of *Perognathus*, which is almost entitled to rank as a full genus).

The Sonoran Region may be divided by temperature into two principal transcontinental zones, (*a*) *Upper Sonoran*, and (*b*) *Lower Sonoran*;§ and each of these in turn may be subdivided into *arid* and *humid* divisions.

The gray fox, *Urocyon*, ranges over both Upper and Lower Sonoran from Atlantic to Pacific; and pocket gophers of the

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*The generic name *Hesperomys* being untenable, Allen has recently substituted for it the name *Vesperimus*, proposed by Coues as a subgenus in 1874 (Bull. Am. Mus. Nat. Hist., III, No. 2, June, 1891, pp. 291–297). *Vesperimus* is antedated by *Sitomys* of Fitzinger, proposed in 1867, and based on Gapper's *Cricetus myoides* from Lake Simcoe, Ontario, Canada (Sitzungsber. math. nat. Classe, K. Akad. Wiss. Wien, LVI, 1867, p. 97). Gapper's *Cricetus myoides* is the common white-footed mouse of southern Ontario and northern New York, which therefore becomes the type of the genus.

†*Xerospermophilus*, subgen. nov., proposed for *Spermophilus mohavensis* (type) and the allied species of the *S. spilosoma* group.

‡*Ammospermophilus*, subgen. nov., proposed for *Spermophilus leucurus* (type) and allied species.

§The great Lower Sonoran Zone may be split lengthwise (in an east and west direction) into two belts which have not yet been thoroughly differentiated.

genus *Geomys* inhabit both these divisions on the Great Plains and in the Mississippi Valley, and range east to the Atlantic in the Austroriparian Zone.

Both divisions of the Lower Sonoran are inhabited by the transcontinental genera *Reithrodontomys*, *Sigmodon*, *Corynorhinus*, *Nyctinomus*, *Otopterus*, *Neotoma*, and *Spilogale*, though in the west the two last mentioned range through the Upper Sonoran also.

The humid Lower Sonoran or *Austroriparian* is a division of much importance. It begins on the Atlantic seaboard at the mouth of Chesapeake Bay and stretches thence southwesterly, embracing the alluvial lands of the South Atlantic and Gulf States below what geologists know as the 'fall line,' rising in the Mississippi bottom as far as the junction of the Ohio with the Mississippi, and following the former in a narrow strip to the point where it receives the Wabash. On the west side of the Mississippi it crosses Arkansas, reaches southern Missouri and southeastern Kansas, and spreads out over Indian and Oklohoma Territories and Texas, where it loses its moisture and merges insensibly into the arid Sonoran. *Oryzomys* and *Nycticejus* are distinctive Austroriparian genera. Six other genera (*Neotoma*, *Reithrodontomys*, *Geomys*, *Spilogale*, *Nyctinomus*, and *Corynorhinus*), which in the region east of the Mississippi seem to be restricted to this division, have a more extended range in the west. The cotton rat (*Sigmodon*), another characteristic Austroriparian genus, has a very limited range in the arid Sonoran.

The arid Lower Sonoran extends westerly from the humid Sonoran to the Pacific, covering southern New Mexico and Arizona south of the plateau rim (sending a tongue up the Rio Grande to a point above Albuquerque), the west side of which it follows northerly to the extreme northwestern corner of Arizona and the southwestern corner of Utah (where it is restricted to the valley of the lower Santa Clara, or St. George Valley), and thence westerly across Nevada, reaching northerly to Pahranagat, Oasis, and Owens Valleys, and thence curving southwesterly, following the eastern base of the Sierra Nevada, Tehachapi, and Tejon Mountains, and covers the whole of the Mohave and Colorado Deserts and all the rest of southern California except the mountains. It sends an arm southward over most of the peninsula of Lower California, and another northward covering the San Joaquin and Sacramento Valleys. The distinctive mammals

of the arid Lower Sonoran are kangaroo rats of the genus *Dipodomys*, pocket mice of the subgenus *Chætodipus*, and spermophiles of the subgenera *Xerospermophilus* and *Ammospermophilus*.

The peninsula of Lower California is a subdivision of the arid Lower Sonoran Zone. Not a single genus of land mammal or bird is restricted to it and but two peculiar species of mammals have been described. The peculiar birds are more numerous, but with few exceptions are only subspecifically separable from those of neighboring parts of the United States and Mexico. They may be classed in two categories: (1) Mountain forms derived from the North (of Boreal or Transition origin); and (2) lowland forms derived from the contiguous plains (of Sonoran, or in one instance subtropical, origin). As would be expected from the character of the country, the great majority are subspecies of well-known Sonoran forms, with the addition of a small number of peculiar species belonging to Sonoran genera. But a single subtropical bird is known, namely, *Dendroica bryanti castaneiceps*, and it is restricted to the mangrove lagoons.

The presence of this subtropical bird in the narrow coast lagoons is in complete accord with the vegetation of the coast strip, which, as Mr. T. S. Brandegee tells us, is subtropical.* This indicates the presence of a narrow coast belt similar to that of southern Florida, but of less extent. It is possible that *Basilinna xantusi* is subtropical rather than Sonoran, but the details of distribution of the genus are not well known.

Among reptiles, about 25 peculiar species of snakes and lizards are believed to be restricted to the peninsula, but no peculiar genus is known. Three of the genera are tropical, and nine are arid Lower Sonoran.

In addition to the peculiar species and subspecies of the peninsula, many characteristic arid Lower Sonoran forms of mammals, birds, reptiles, insects, and plants abound. Among the latter may be mentioned the highly distinctive Sonoran desert brush, *Larrea mexicana* and *Krameria parrifolia*.

Cope includes the whole peninsula in his *Lower Californian Region*, but other writers restrict the peculiar fauna and flora to the end of the peninsula south of the north foot of the mountains between La Paz and Todos Santos. Bryant states: "There is no more sharply defined faunal and floral area, that occurs to

* Brandegee, Proc. Calif. Acad. Sci., 2d ser., III, 1891, 110.

me now, excepting that of islands, than is embraced in the region above defined,"* but he omits to name the forms by which it is characterized. It is evident, however, that the peculiar fauna of the peninsula of Lower California entitles it to rank as a minor subdivision of the Lower Sonoran Zone. It is in effect an insular fauna of recent origin, bearing the same relation to that of the mainland as do several of the adjacent islands.

The humid division of the Upper Sonoran comprises the area in the eastern United States commonly known as the Carolinian Fauna. The opossum (*Didelphis*) here finds its northern limit, as do the so-called pine mouse (subgenus *Pitymys*) and the Georgian bat (*Vesperugo georgianus*). Before reaching the 100th meridian this area gradually loses its moisture and spreads out over the Great Plains as the arid or true Upper Sonoran, reaching an altitude of about 4,000 feet along the east foot of the Rocky Mountains in the latitude of Colorado, and sending a tongue northward along the Missouri obliquely through North Dakota and into eastern Montana. Another subdivision of the arid Upper Sonoran occupies the greater part of the Great Basin between the Rocky Mountains and the High Sierra, reaching northerly from the upper border of the Lower Sonoran to and including the plains of the Columbia and Snake Rivers. Another part of noteworthy extent is a narrow belt encircling the interior basin of California—the valley of the Sacramento and San Joaquin rivers—and a branch of the same along the coast between Monterey and the Santa Barbara plain. The following genera of mammals find their northern limit in the arid Upper Sonoran Zone: *Perodipus*, *Microdipodops*, *Perognathus*, *Onychomys*, *Spilogale*, *Urocyon*, *Bassariscus*, and *Antrozous*.

Interposed between the Boreal and Sonoran Regions throughout their numerous windings and interdigitations, is the Neutral or Transition Zone. The humid division of this zone, known as the Alleghanian Fauna,† covers the greater part of New

* Walter E. Bryant in Zoe, II, No. 3, Oct., 1891, 186. See also his important 'Catalogue of the Birds of Lower California,' Proc. Calif. Acad. Sci., 2d ser., II, 1889, 237–320.

† Prof. Louis Agassiz, in his highly important work on Lake Superior, clearly recognized the transition nature of this zone, for he says: "The State of Massachusetts, with its long arm stretched into the ocean eastward, or rather the region extending westward under the same parallel through the State of New York, forms a natural limit between the vegeta-

England (except Maine and the mountains of Vermont and New Hampshire) and extends westerly over the greater part of New York, southern Ontario, and Pennsylvania, and sends an arm south along the Alleghanies all the way across the Virginias, Carolinas, and eastern Tennessee, to northern Georgia and Alabama. In the Great Lake region this zone continues westerly across southern Michigan and Wisconsin, and then curves northward over the prairie region of Minnesota, covering the greater parts of North Dakota, Manitoba, and the plains of the Saskatchewan; thence bending abruptly south, it crosses eastern Montana and Wyoming, including parts of western South Dakota and Nebraska, and forms a belt along the eastern base of the Rocky Mountains in Colorado and northern New Mexico, here as elsewhere occupying the interval between the Upper Sonoran and Boreal Zones.

In Wyoming the Transition Zone passes broadly over the well-known low divide of the Rocky Mountains, which affords the route of the Union Pacific railway, and is directly continuous with the same zone in parts of Colorado, Utah, and Idaho, skirting the Boreal boundaries of the Great Basin all the way around the plains of the Columbia, sending an arm northward over the dry interior of British Columbia, descending along the eastern base of the Cascade Range and the High Sierra to the southern extremity of the latter, and occupying the summits of the Coast Ranges in California and of many of the desert ranges of the Great Basin.

The Transition Zone, as its name indicates, is a zone of overlapping of Boreal and Sonoran types. Many Boreal genera and species here reach the extreme southern limits of their distribution, and many Sonoran genera and species their northern limits. But a single mammalian genus (*Synaptomys*) is restricted to the Transition Zone, and future research may show it to inhabit the Boreal Region also.

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tion of the warm temperate zone and that of the cold temperate zone. * * * Not only is this also the northern limit of the culture of fruit trees, but this zone is equally remarkable for the great variety of elegant shrubs which occur particularly on its northern borders, where we find so great a variety of species belonging to the genera, Celastrus, Crataegus, Ribes, Cornus, Hamamelis, Vaccinium, Kalmia, Rhodora, Azalea, Rhododendron, Andromeda, Clethra, Viburnum, Cephalanthus, Prinos, Dirca, Celtis, &c." (Lake Superior, 1850, 182–183.)

The following Boreal genera of mammals disappear in the Transition Zone:

Tamias *	Vulpes *
Fiber †	Cervus
Evotomys	Ovis *
Zapus	Ursus *
Erethizon	Neurotrichus
Arctomys	Condylura

The following Sonoran genera of mammals disappear in the Transition Zone:

Antilocapra	Perognathus
Cynomys	Bassariscus ‡
Spilogale ‡	Urocyon ‡
Geomys	Scalops
Thomomys ⁒	

As already stated, the only mammalian genus apparently restricted to the Transition Zone is *Synaptomys*—a lemming mouse. A number of species, however, seem to be nearly or quite confined to this zone. Among these are the following:

Sciurus aberti	Spermophilus spilosoma pratensis
fossor ‖	grammurus
carolinensis leucotis	townsendi ‖
Tamias merriami	Cynomys leucurus
minimus	Sitomys nebrascensis
pictus	boylii
striatus	michiganensis
Spermophilus elegans	Arvicola mogollonensis
richardsoni	austerus minor
obsoletus	curtatus

* Except one species, which inhabits a limited part of the Sonoran Region.

† *Fiber* ranges south beyond the normal limit of the Transition Zone, but it does so along the banks of cool streams that give it a much lower temperature than that of the surrounding atmosphere. It is probable that both *Fiber* and *Castor* should be classed with aquatic species, the limits of their distribution depending on the temperature of the water. The same is true in a less degree of the paludal subgenera *Neosorex* and *Atophyrax* (of *Sorex*) and of the semi-amphibious members of the subgenus *Mynomes* (of *Arvicola*).

‡ These genera barely enter the Transition Zone at all except in a very small area in the far West.

⁒ Except on high mountains in the Sonoran Region.

‖ Range down into Upper Sonoran also.

Arvicola pallidus
Synaptomys cooperi
Lepus americanus virginianus
campestris
idahoensis *
sylvaticus nuttalli *
Perognathus fasciatus
olivaceous
Putorius nigripes *
Vulpes velox
Scapanus americanus
Vespertilio melanorhinus

Local elevations of the land in the Sonoran Region are capped with isolated patches of Transition or Boreal species, according to the temperature to which their summits attain: and if the elevation is sufficient to secure a Boreal fauna and flora the latter is always separated from the Sonoran of the surrounding plane by a belt or girdle of Transition Zone forms.

The Tropical Region reaches the United States at two remote points—Florida and Texas. In the former it exists as a narrow subtropical belt encircling the southern half of the Peninsula from Cape Malabar on the east to Tampa Bay on the west. In Texas it crosses the Lower Rio Grande from Mexico and extends north to the neighborhood of the Nueces River. In western Mexico the Tropical Region reaches Mazatlan.

Fourteen families of Tropical mammals inhabit North America north of Panama, namely:

Didelphidæ
Bradypodidæ
Myrmecophagidæ
Dasypodidæ
Dicotylidæ
Tapiridæ
Octodontidæ
Dasyproctidæ
Procyonidæ
Solenodontidæ
Emballonuridæ
Phyllostomatidæ
Hapalidæ
Cebidæ

Of the above fourteen families, six reach the United States, namely, *Didelphidæ*, *Dasypodidæ*, *Dicotylidæ*, *Procyonidæ*, *Emballonuridæ*, and *Phyllostomatidæ*, and two of the latter (*Didelphidæ* and *Procyonidæ*) penetrate the entire breadth of the Sonoran Region, the *Procyonidæ* even entering the lower edge of the Boreal. Descending from families to genera, it is found that no less than 62 tropical genera of non-pelagic mammals inhabit North America north of Panama, of which number 9 enter the United States from Mexico, namely, *Didelphis*, *Tatusia*, *Dicotyles*, *Nasua*, *Procyon*, *Felis*, *Molossus*, *Nyctinomus*, and *Otopterus*. Of these, *Didelphis*, *Felis*, and *Procyon* now reach considerably further north than the others, as just pointed out in speaking of the

* Range down into Upper Sonoran also.

families to which they respectively belong. In explanation of this extended range it is found that these genera inhabited North America in pre-glacial times and as a consequence have become acclimatized to a wider range of climatic conditions. The semi-Tropical belt of Florida is not known to possess any tropical mammals except bats and a large indigenous mouse (*Sitomys macropus*)*, but it has not been explored by experienced mammal collectors. Still, its recent origin and complete isolation from other tropical areas would indicate the absence of terrestrial species derived from the south. At the same time it is known to be rich in tropical plants, land shells, insects, and birds, as is shown in another part of the present paper (see pp. 51–53). It contains 9 genera of tropical birds, namely, *Zenaida*, *Geotrygon*, *Starnœnas*, *Rostrhamus*, *Polyborus*, *Crotophaga*, *Euetheia*, *Callichelidon*, and *Cereba*.

The following 62 genera of mammals belong to the North American Tropical Region. The nine preceded by the letter *S* enter the southern United States, which they penetrate varying distances. *Nyctinomus* and *Otopterus* inhabit the Lower Sonoran Zone in common with the Tropical; *Didelphis* pushes completely through the humid division of the Sonoran Region; and *Felis* and *Procyon* enter the lower edge of the Boreal.

North American Tropical Genera.

Chironectes	*S* Felis	Lonchorhina
S Didelphis	*S* Procyon	*S* Otopterus
Bradypus	Bassaricyon	Vampyrus
Cholœpus	*S* Nasua	Micronycteris
Myrmecophaga	Cercoleptes	Trachyops
Tamandua	Galictis	Phyllostoma
Cyeloturas	Solenodon	Mimon
S Tatusia	Natalus	Hemiderma
S Dicotyles	Rhynchonycteris	Glossophaga
Elasmognathus	Saccopteryx	Phyllonycteris
Capromys	Diclidurus	Monophylla
Plagiodontia	Noctilio	Leptonycteris
Echinomys	*S* Molossus	Glossonycteris
Synetheres	*S* Nyctinomus	Chœronycteris
Dasyprocta	Chilonycteris	Artibeus
Cœlogenys	Mormops	Vampyrops

* Described by the writer as *Hesperomys macropus* in N. Am. Fauna, No. 4, Oct., 1890, p. 53.

Stenoderma	Centurio	Chrysothrix
Chiroderma	Desmodus	Nyctipithecus
Pygoderma	Diphylla	Ateles
Sturnira	Midas	Cebus
Brachyphylla	Mycetes	

Recapitulating, it is found that of the one hundred and thirty four genera of non-pelagic mammals inhabiting North America north of Panama, fifty-three are exclusively Tropical, twenty exclusively Sonoran, and twenty exclusively Boreal. In addition to these genera, which do not outstep the limits of the regions to which they severally belong, a number of others are clearly referable to the same regions, though ranging varying distances beyond their proper boundaries. Including these genera, the number belonging to each region is as follows: Tropical, sixty-two; Sonoran, thirty-four; Boreal, thirty-one—thus leaving but seven genera out of a total of one hundred and thirty-four that are not distinctly referable to one of the three regions. One of these (*Synaptomys*) is not known to occur outside the limits of the Transition Zone, leaving but six genera that have not been assigned. These genera are *Sciuropterus*, *Sciurus*, *Spermophilus*, *Lepus*, *Canis*, and *Lutra*, each of which ranges over large parts of both Boreal and Sonoran Regions. All except *Spermophilus* inhabit the Tropical Region also, and all are of great antiquity, as will be shown presently (p. 37). The genera *Spermophilus* and *Lepus* might be referred to the Sonoran Region because the great majority of their species are confined to it; and for the same reason *Sciurus* might be considered Tropical and Sonoran.

Omitting Mexico and Central America, and regarding the nine intrusive Tropical genera already mentioned as Sonoran (in contradistinction to Boreal), it is found that eighty-one genera of non-pelagic mammals inhabit the United States and Canada, of which forty-three may be looked upon as of Sonoran origin and thirty-one as of Boreal origin. The seven genera remaining are those mentioned in the last paragraph.

TABLE SHOWING THE GEOGRAPHIC DISTRIBUTION OF NORTH AMERICAN GENERA OF NON-PELAGIC MAMMALS OCCURRING NORTH OF MEXICO.

Boreal Genera.

Cervus	Arvicola *	Ursus *
Rangifer	Fiber *	Thalarctos
Alce	Evotomys	Latax
Ovis *	Phenacomys	Gulo
Mazama	Myodes	Mustela
Bison (?)	Cuniculus	Lutreola *
Ovibos	Zapus	Putorius *
Tamias *	Erethizon	Sorex*
Arctomys	Lagomys	Neurotrichus (?)
Aplodontia	Vulpes*	Condylura
Castor *		

Sonoran Genera.

Cariacus †	Perodipus	Notiosorex
Antilocapra	Microdipodops	Blarina†
Cynomys	Perognathus	Scapanus
Reithrodontomys	Heteromys	Scalops
Onychomys	Lynx †	Corynorhinus
Sitomys†	Urocyon	Euderma
Oryzomys	Bassariscus	Antrozous
Sigmodon	Taxidea	Nycticejus
Neotoma †	Conepatus	Vesperugo †
Geomys	Mephitis †	Atalapha †
Thomomys	Spilogale	Vespertilio †
Dipodomys		

Tropical Genera.

Didelphis	Felis †	Molossus
Tatusia	Procyon †	Nyctinomus
Dicotyles	Nasua	Otopterus

Transition Zone Genera.

Synaptomys

Genera Inhabiting both Boreal and Sonoran Zones.

Sciuropterus	Spermophilus	Lutra
Sciurus	Canis	Lepus

* Having one species in Sonoran Zone or reaching Sonoran.

† Having one species in Boreal Zone or reaching southern edge of Boreal.

Distinctness of the Tropical Region from the Sonoran.

It has been shown that the fauna and flora of Tropical America reach the United States, though in a somewhat dilute condition, along the lower Rio Grande in Texas, and in southern Florida, and that in the vast majority of cases their genera and species differ widely from those of other parts of America. Except for the presence, chiefly in the southern United States, of a comparatively few forms derived from the Tropical region, the fauna and flora of North America are as distinctive and independent of the existence of this area as if separated from it by the broad ocean. Among the eighty-one genera of non-pelagic *Mammalia* inhabiting North America north of Mexico the number of these intrusive genera is only nine,* as has been shown, and three of these are bats. These genera are: *Didelphis*, *Tatusia*, *Dicotyles*, *Felis*, *Procyon*, *Nasua*, *Molossus*, *Nyctinomus*, and *Otopterus*. *Tatusia* and *Nasua* barely reach our southern boundary; *Dicotyles* extends only part way through Texas; *Molossus* a short distance into southern California; *Nyctinomus* and *Otopterus* do not pass beyond the Lower Sonoran Zone, and *Didelphis* is restricted to the humid division of the Sonoran. Out of the nine intrusive genera, therefore, but two (*Felis* and *Procyon*) reach the southern edge of the Boreal.

On the other hand, a few groups, such as the wolves, otters, squirrels, and rabbits (genera *Canis*, *Lutra*, *Sciurus*, *Sciuropterus*, *Spermophilus*, and *Lepus*) occur over large parts of both North and South America, presenting a seeming obstacle to the acceptance of the view that the faunas in question are so wholly dissimilar. But investigation shows that these animals are almost world-wide in distribution, implying great antiquity of origin, and remains of most of them have been found as low down at least as the Miocene strata in both America and Eurasia. Hence it is clear that these types became diffused over North and South America at a very distant period, and their peculiar habits of life, though wholly dissimilar, enabled them to survive the great mutations these land areas have undergone since Miocene times.

The paucity of species of tropical derivation in North America is the more remarkable in view of the absence of barriers of any kind, save climatic conditions alone, to impede the free in-

*Among birds the number of intrusive forms is greater, as would be expected from their superior powers of locomotion and dispersion.

gress of species from the south. No mountain range or arm of the sea or other tangible obstacle marks the northern boundary of the semi-tropical fauna of northeastern Mexico where it ends abruptly near the Nueces River in Texas, or the semi-tropical belt of Florida where it ends near Tampa Bay on the west and Cape Malabar on the east.

If the Tropical fauna and flora stopped at the narrow Isthmus of Panama, or even in southern Nicaragua, where the last union of the North and South American continents probably took place, the case would be very different; but instead of doing this it pushes northward 1,500-2,000 miles and ends abruptly where the most painstaking search fails to reveal any barrier to further extension except an uncongenial decrease in temperature and humidity (see also remarks under change of climate following Pleistocene times p. 44.)

No more striking illustration could be desired of the potency of climate compared with the inefficiency of physical barriers than is presented by the almost total dissimilarity of the North American Tropical and Sonoran Regions, though in direct contact, contrasted with the great similarity of the Boreal Regions of North America and Eurasia—now separated by broad oceans, though formerly united, doubtless, in the region of Bering Sea. Of the thirty-one Boreal genera of North American mammals all but eight, or three-fourths, occur also in Eurasia, and but a single family is restricted to cold-temperate America. This family (the *Aplodontidæ*) is the sole representative of a group approaching extinction, and the accident of its survival (in a single genus and two closely related species) in a very limited area along our west coast can hardly be construed as of much faunal significance. Contrasted with this one family (which ought not to be counted) and eight genera of Boreal North American mammals not occurring in Eurasia, Tropical North America (Central America and part of Mexico, exclusive of the West Indies) has no less than eight families and fifty-three genera not belonging to the immediately adjoining Sonoran Region of the southern United States and the plateau of Mexico.

The Sonoran not a Transition Region.

Before leaving this part of the subject reference should be made to the view recently advanced by some naturalists, notably by

Angelo Heilprin, that the Sonoran Region is itself a 'Transition Region' between the Boreal and Tropical Faunas and Floras. The incorrectness of this hypothesis is easily demonstrated, for it rests upon the assumption that the Sonoran Region is a mixture of Boreal and Tropical forms. The contrary has just been shown to be the case, the hiatus between the Sonoran and Boreal on the one hand and the Sonoran and Tropical on the other being not only immense, but vastly greater than that between Boreal America and Eurasia.

Differentiation of life from the north southward.

Animals and plants inhabiting the Arctic regions are usually specifically identical throughout Arctic America, Greenland, and the polar parts of Eurasia and outlying islands, while as they diverge from the pole southward they tend to split up into many species; in other words, Boreal species are more stable and persistent than those inhabiting warmer countries. The explanation of this fact is obvious. The identity of climate and environment throughout the Arctic Zone tends to preserve identity of specific characters, giving rise to a homogeneous fauna and flora, while the diversity of physical conditions and climatic influences prevailing in an increasing degree at greater distances from the pole exerts a powerful influence upon the various forms of life, producing first local geographic races or subspecies, then species, and finally groups of species constituting well-marked subgenera and even genera, giving rise to greatly diversified faunas and floras. Thus among mammals the polar or ice bear (*Thalarctos maritimus*) has no very near relative, and is replaced in the tundras by the brown and barren-ground bears (*Ursus arctos* and *richardsoni*), which run into several more or less distinct forms, as the snow bear (*U. isabellinus*), Syrian bear (*U. syriacus*), and hairy-eared bear (*U. piscator*). Besides these are the grizzly (*U. horribilis*, of which two forms may be recognized) and the black bears of America and Eurasia (*U. americanus*, *torquatus*, and *japonicus*); and still further southward the group becomes differentiated into several well-marked genera.

In like manner the Arctic fox is replaced to the southward, first, by the red foxes of America and Eurasia, of which several subspecies are known; second, by a number of quite distinct

species, and third, by additional types, at least one of which in our own country is entitled to generic rank (*Urocyon*).

The ermine and polar hare are the sole Arctic representatives of groups which in the temperate parts of Europe and America comprise many distinct species, and in the case of the former, several well marked subgenera.

The Arctic lemmings (genera *Myodes* and *Cuniculus*) are numerously represented in the north temperate parts of the world by the genera *Ellobius*, *Synaptomys*, *Phenacomys*, *Evotomys*, *Fiber*, and *Arvicola*.

It is not to be inferred from the above remarks that the polar representatives of these various groups are to be looked upon as the parent stocks from which the other members sprang. Usually the reverse is the case, for groups of Boreal origin that now attain their maximum development in north-temperate regions have their numbers reduced in the Arctic circle to a single representative. But, regardless of centers of origin, it is here intended to emphasize the fact that types inhabiting the Arctic Zone are few in number and uniform in character throughout their distribution, while to the southward the same types become more and more diversified and new types appear as the distance from the Pole increases,* so that it may be formulated as a general proposition that in continental areas *the further from the Poles the larger the number of families, genera, and species.*†

*The elder Agassiz long since pointed out that "the vegetation of the two continents becomes more and more homogeneous the more we advance northward" (Lake Superior, 1850, 153). Stated conversely, this is in complete accord with the "Law of differentiation from the north southward" formulated by Allen as "a constant and accelerated divergence in the characters of the animals and plants of successive regions of the continent." (Bull. Mus. Comp. Zool. II, 1871, 379.) In a later contribution the same author speaks of the "high rate of differentiation favored by tropical conditions of climate," and adds that Arctic and cold-temperate climates are characterized by only slightly or moderately diversified faunas; that a moderate increase of temperature results in the addition of many new types; and that "a high increase in temperature, giving tropical conditions of climate," is accompanied by "a rapid multiplication of new forms and a maximum of differentiation."

†This is a general proposition intended to apply to terrestrial forms of life *collectively*, and does not conflict with the law that the maximum number of species in each particular group is found in the zone or area which is the center of its distribution.

Origin of Types and Faunas—Geologic Evidence.

In speaking of the Boreal and Sonoran origin of species and groups in the present paper, the term '*origin*' is used exclusively in a sense intended to indicate *present centers of distribution*—not real or ancient centers of origin—for it must be borne in mind that the history of the inhabitants of the earth is not only a history of the successive appearance and disappearance of types now extinct, but a history of great movements—of vast migrations to and fro over the surface of the globe—and little is known of the real points of origin of our Boreal and Tropical faunas and floras. The geologic evidence demonstrates that in the past large land areas have been many times joined together and many times rent asunder. The establishment of land continuity between areas previously disconnected has made it possible for new forms of animals and plants to obtain a footing and spread over regions previously uninhabited by them—often, doubtless, at the expense of the indigenous fauna and flora. Even great continents, as North and South America, have been more than once united and separated; and the last union of these continents is so recent we can distinctly trace at the present day the course and distribution of the intrusive forms.

On the other hand, in comparatively recent times, multitudes of species and genera, and even families and higher groups, have suddenly disappeared from large areas where they were formerly abundant, and some of them from the face of the earth, so that the fauna of the recent past compared with that of today presents some strange contrasts. North America in Pleistocene times was inhabited by associations of mammals not now living on this continent but found in as far distant parts of the earth as Asia and South America; for horses, camels, and elephants then lived here with llamas, tapirs, and capybaras. With them were others now altogether extinct, as huge tigers, wolves, cave bears, the great Mastodon, the Megatherium, Megalonyx, Mylodon, and other gigantic sloths.

Glacial Epoch.

The cause of this sudden extermination of dominant types is believed to have been the Glacial epoch, which is known to have driven species of animals and plants from the poles to the

tropics, and which explains several of the otherwise inexplicable problems presented in the study of the past and present distribution of life.

The snows at the beginning of the Glacial epoch fell upon a continent of great forests—forests that gave shelter to multitudes of mammals and birds and other forms of life, a large proportion of which no longer inhabit America, and many of which do not exist in any part of the globe.

During the period of maximum development the great glacier is believed to have been not less than 8,000 feet in thickness in northern New England, and its southern border crossed New Jersey and Pennsylvania, and thence, curving irregularly southwesterly to southern Illinois and then northwesterly, finally reached the Pacific Ocean in British Columbia. The disastrous effect upon animals and plants of this tremendous body of ice must have reached far south of its actual borders.

The Glacial epoch is believed to have been made up of at least two principal and a number of minor advances and retreats, separated by long intervals and accompanied doubtless by corresponding fluctuations in the northern boundaries of the faunal and floral areas immediately to the south; for it is reasonable to suppose that throughout the period covered by the movements of the ice mantle, and probably in later preglacial times as well, the forms now known as Boreal and Arctic (or their immediate ancestors) inhabited areas characterized by temperatures not very different from those they now require, and that the northern limit of each species kept at a certain uniform distance from the ice line. "Plants," says Dr. Gray, "are the thermometers of the ages, by which climatic extremes and climates in general are best measured."

Important evidence of the correctness of this hypothesis is afforded by the well known presence of colonies or assemblages of arctic species on isolated mountain summits in southern latitudes, where the altitude carries them into the low temperature of their homes in the far North. It is obvious that such colonies could not have reached their present positions during existing climatic conditions. But during the return movement of animal and plant life following the retreat of cold at the close of the Glacial epoch, many Boreal species were stranded on mountains, where, by climbing upward as the temperature increased, they were enabled to survive, finding a final resting place with a

climate sufficiently cool for their needs, and here they have existed to the present day.*

Throughout the growth of the great ice mass and its extension from the north southward it is clear that the animals and plants that could not keep pace with its advance must have perished, while the steady pushing toward the tropics of those that were able to escape to the rapidly narrowing land in that direction must have resulted in an overcrowding of the space available for their needs and a corresponding increase in the severity of the struggle for existence. The sustaining capacity of a region is limited; hence such a thing as overcrowding, in the sense of greatly increasing the number of organisms a region can support, is an impossibility, for beyond a certain limit all excess of life must perish—overcrowding inevitably leading to death. The mortality in any one year may not have been great, but during the untold ages covered by the movements of the continental ice the aggregate destruction of life must have been stupendous.

Immediately upon the close of the Glacial epoch life began to reclaim the regions from which it had been so long shut out. This overflow released the tension under which the animals and plants had been struggling for ages and rendered the contest for existence less severe. Overproduction had at last found an outlet, and life became possible to a constantly increasing number of individuals. Normal reproduction was sufficiently rapid to supply occupants for the regions made habitable by the slow recession of the ice, and the advance of both plants and animals kept pace, doubtless, with its progressive increase. But the species that survived to return were only in part those driven out. Many had been overtaken by the cold or had perished in the journey southward; others were driven into inhospitable regions where the environment was not suited to their needs; others still succumbed in the struggle resulting from overcrowding, and some that outlived the first great period of glaciation perished during the second. Gilbert tells us that a detailed study of the ancient lake beds of the

* In a former communication attention was called to the circumstance that the presence or absence of such arctic-alpine colonies on high volcanic mountains may be of use to the geologist as affording evidence of the age of the volcanic activity resulting in the upheaval of the mountain, the absence of Arctic or Boreal forms indicating postglacial origin. (N. Am. Fauna, No. 3, September, 1890, p. 21.)

Great Basin "shows two lacustral epochs corresponding to two glacial epochs, and correlates the mammalian fauna with the later half of the later Glacial epoch. Presumptively this date falls very late in the Pleistocene period." (Lake Bonneville, by G. K. Gilbert, 1890, 397.) The mammalian fauna referred to comprises an elephant, an otter, two horses, three llamas, a deer of the genus *Cervus*, an ox, a gigantic sloth, together with three species now living, namely, the coyote, beaver, and pocket gopher (*Thomomys*). No new types came in to take the place of those exterminated; hence we in the United States now live in a region deprived of many of the groups to which it gave birth, and we are forced to visit remote parts of the earth to see animals and plants that once attained their maximum development in North America, while others that formerly flourished here are entirely extinct.

Not only are the pre-Pleistocene animals and plants now represented imperfectly and in greatly reduced numbers, but the areas at present inhabited by their descendants, except in the case of the Boreal forms, are insignificant in comparison with their former extent. It should be remembered that the refrigeration of the Glacial epoch has only in part disappeared. In early Pliocene times characteristic representatives of subtropical faunas and floras existed northward over much of the United States and Canada, and in still earlier times reached the Arctic Circle.* During the advance of cold in the Glacial epoch these forms were either exterminated or driven southward into the narrow tropical parts of Mexico and Central America. The retreat of cold at the termination of this period was not complete, and our continent has never regained its former warmth. Hence the expelled species were not permitted to advance more than a short distance into the region formerly occupied by them, and the tropical species have been held back and at the present day are not found except along the extreme southern confines of our territory. For example, peccaries in early Pleistocene times ranged northward over a large part of western America, while at present they are restricted to parts of Texas and Louisiana below the Red River of the South; and the capybaras, tapirs, and other tropical

* Among trees fossil remains of magnolia, sassafras, and liquidamber have been found in Greenland.

forms whose fossil remains have been found in many parts of the United States have not been able to return. The same is true of plants, for the palms, tree-ferns, and numerous other tropical types that formerly ranged over much of our country are now either altogether extinct or exist only in the tropics.

The llama and many plants now inhabiting the Andes may be looked upon as representing a class of cases in which Boreal forms were driven so far south that they actually reached the great mountain system of South America and spread southward over its elevated plateaus and declivities to the extreme end of the continent in Patagonia and Terra del Fuego. This fact has been long recognized by botanists.

The paleontologic history of the earth shows that many groups now unknown came into existence from preceding groups, gradually attained a maximum development, and as gradually passed away; but there are few records of breaks in the geologic series, or of disturbances of any kind from the earliest appearance of life to the present time, that have resulted in the destruction of so many types as the cold of the Glacial epoch.

Causes controlling distribution.

It is now pretty generally conceded that temperature and humidity are the chief factors governing the distribution of life, and that temperature is more potent than humidity. Illustrations of this law have been already given in contrasting the humid and arid elements of the several zones with the zone elements as limited by temperature, and it has been found in the case of mammals and birds that the effects of temperature, estimated numerically, are more than three times greater than the effects of humidity upon genera, and many times greater upon the higher groups.

Authors differ as to the exact period during which temperature exerts the greatest influence, but there can be little doubt that for both animals and plants it is *the season of reproductive activity*, and hence varies inversely with latitude and altitude. In high arctic latitudes this period is very brief, while in the humid tropics it seems to extend over nearly if not quite the whole year.*

Whether the temperature in question is the mean of a certain

* This was pointed out by the author in North Am. Fauna No. 3, September, 1890, pp. 26–27.

period or the sum of the daily temperatures for that period, or the sum in excess of a certain minimum, expressed in degrees of the thermometric scale or in calories, and how to determine the precise beginning and ending of this period for each locality, are questions respecting which difference of opinion prevails; and authors are not agreed as to whether the temperature should be taken in the sun or in the shade, or at a certain distance below the surface of the earth. At the same time it has been demonstrated by Linsser and others that a definite quantity of heat is required to complete the process of reproduction in a number of plants experimented upon—and nature's laws are not framed for isolated cases. This law is taken advantage of by expert gardeners and horticulturists who are able to so regulate the temperature of their green-houses that they can produce a perfect flower or a ripe fruit on a specified day.

A few species, particularly among plants, are so sensitive to cold that they are limited in northward range by the line of killing frost, but in the vast majority of cases the winter temperature is of no consequence. As I have already shown, "The season of reproduction for the plant, as for the animal, is the warm part of the year. After the period of reproduction the plant withers; after it flowers and fruits and matures its seed, it dies down or becomes physiologically inactive. And what the plant accomplishes in one way the animal accomplishes in another. To escape the cold of winter and its consequences, the sensitive mammal hibernates; the bird migrates to a more southern latitude; the reptile and batrachian dig holes in the mud or sand and remain in a torpid condition; the insect sleeps in its cocoon or buries itself under leaves or decomposing vegetation; and none but the hardier forms of life are left to be affected by winter temperatures." (N. Am. Fauna, No. 3, September, 1890, 26–27.)

After temperature and humidity, several subordinate though important factors remain to be considered. Among these may be mentioned the duration and actinic effects of sunlight (governed in part by percentage of cloudiness or fog and by the mechanical purity of the atmosphere). The character of the soil also determines the presence or absence of many species.*

*The controlling causes of distribution will not be discussed further here because they are the subject of another communication upon which the writer is engaged.

Effects of humidity contrasted with effects of temperature.

With few exceptions, the Boreal zones, owing to their low temperatures, precipitate sufficient moisture to support arboreal vegetation and do not possess arid areas. The Transition and Sonoran zones on the other hand naturally fall into two important subdivisions, *arid* and *humid*, as indicated in defining their courses. As a rule the former consist of treeless plains, deserts, and barren mountains, while the latter are bountifully clothed with forests. Most of the humbler forms of vegetation are different in the two subdivisions, and differences exist also among the mammals, birds, and reptiles; but the great majority of these dissimilarities are not of the same kind as those that distinguish one zone from another. Most of them are specific—not generic—and the number of distinctive groups of high order is very much less. This may be made clear by selecting the distinctive elements of the arid Sonoran (which has the largest number of peculiar forms) in comparison with those of the humid Sonoran (or Austroriparian) and contrasting them numerically with the distinctive elements of the Sonoran as a whole compared with those of the Boreal as a whole.* Among non-pelagic mammals, the arid Sonoran has one family (*Antilocaprida*) and only ten genera † not known to inhabit the humid Sonoran or Austroriparian; and the latter has but one family (*Didelphidæ*) and four genera (*Didelphis*, *Oryzomys*, *Scalops*, and *Nycticejus*) not found in the arid Sonoran (and the family and one of the genera are intrusions from the Tropical region), while 13 families and 27 genera are common to both arid and humid subdivisions.‡

Among birds, the arid Sonoran has no family and only 24 genera not inhabiting the humid Sonoran, and the latter has no family and but 7 genera not found in the arid, while 12 families and 31 genera are common to the two divisions.

Contrasting the Sonoran as a whole with the Boreal as a whole, it appears that there are no less than 8 families and 41

*The intrusive Tropical genera are here treated as Sonoran.

†These genera are: *Antilocapra*, *Cynomys*, *Onychomys*, *Thomomys*, *Dipodomys*, *Perodipus*, *Microdipodops*, *Perognathus*, *Bassariscus*, and *Antrozous*.

‡The newly discovered genus of *Chiroptera*, *Enderma*, is here omitted because only a single specimen is known and it cannot yet be satisfactorily assigned to its proper faunal position.

genera of mammals and 10 families and about 100 genera of birds distinctive of the Sonoran, and 6 families and 30 genera of mammals and 3 families and about 40 genera of birds distinctive of the Boreal zone. In other words, taking mammals and birds together, the arid Sonoran has one peculiar family and only 34 distinctive genera, and the humid Sonoran one family and 11 genera (of which the family [*Didelphidæ*] and several of the genera are clearly intrusions from the Tropical region), while the Sonoran as contrasted with the Boreal has 18 distinctive families and 141 distinctive genera, and the Boreal has 9 distinctive families and 70 distinctive genera.

Only 8 families and 8 genera of mammals are common to the Boreal and Sonoran Regions. The common families are: *Cervidæ*, *Muridæ*, *Sciuridæ*, *Leporidæ*, *Mustelidæ*, *Canidæ*, *Felidæ*, and *Soricidæ*. The common genera are: *Sitomys*, *Sciurus*, *Sciuropterus*, *Spermophilus*, *Lepus*, *Lutra*, *Canis*, and *Lynx*. Several others inhabit limited parts of both regions, but are not common to these regions as a whole.

With the possible exception of the gray wolf, not a single species of mammal ranges throughout the Sonoran and Boreal Zones, though a number are common to the Upper Sonoran and Lower Boreal (Canadian); and in the case of the wolf it is almost certain that comparison of specimens will show the animal of the southern United States and Mexico to be perfectly distinct from that of Arctic America. The ermine is another species of phenomenal though less extensive range, if it is really true that the weasel inhabiting the shores and islands of the Polar Sea is specifically identical with that found in the more elevated parts of the Southern States—an assumption I cannot for a moment entertain.

In the case of land birds, 18 genera are common to the Boreal and Sonoran Regions. The number of common families is relatively large as would be expected from the wide dispersal of most families of birds. For instance, the *Turdidæ* or thrushes inhabit North and South America, Eurasia, Africa, India, and Australia; the *Paridæ* or titmice inhabit North and South America, Eurasia, Africa, India, Australia, and New Zealand; the *Cinclidæ* or dippers inhabit North and South America, Eurasia, India, and the Austro-Malayan region; the *Troglodytidæ* or wrens inhabit North and South America, Eurasia, India, Africa, and the Austro-Malayan region; the *Corvidæ* or crows, magpies and jays, are found in every part of the world, and so on.

Table Showing Number of Distinctive Families and Genera of Mammals and Birds of the Arid Sonoran Compared with the Humid Sonoran, and of the Sonoran as a Whole Compared with the Boreal as a Whole.

	Mammals		Birds		Total	
	Fam.	Gen.	Fam.	Gen.	Fam.	Gen.
Arid Sonoran distinguished from Humid Sonoran by	1	10	0	24	1	34
Humid Sonoran distinguished from Arid Sonoran by	1	4	0	7	1	11
Common to both Arid and Humid Sonoran	13	27	12	31	25	58
Sonoran as a whole distinguished from Boreal by	8	41*	10	100	18	141
Boreal as a whole distinguished from Sonoran by	6	30†	3	40	9	70
Common to Boreal and Sonoran	8	8		18		26

Descending to species, the contrast is even more marked.

The above table shows, so far as the genera of mammals and birds are concerned, that the difference between the humid 'Atlantic' or 'Eastern Province' on the one hand and the arid Great Plains and Great Basin on the other is less than one-fourth as great as the difference between the Sonoran and Boreal Regions.

These facts, it seems to me, should suffice to establish beyond dispute the subordinate part played by humidity in comparision to temperature, and should dispel any lingering doubts that may still haunt the minds of conservative naturalists respecting the necessity of abandoning the long accepted division of the United States into Atlantic, Central, and Pacific provinces.

Remarks respecting some of Wallace's Fallacies.

Wallace, in his great work on Geographic Distribution, and in subsequent writings on the same subject, greatly underrates the importance of temperature as a factor in determining the distri-

* *Sitomys* and *Lynx* are omitted because they range over most of the forested part of the Boreal Region.

† *Putorius* is omitted because it ranges over much of the Sonoran Region.

bution of life. He lays great stress upon the dissimilarity of the faunas and floras of parts of Africa, South America, and Australia lying in the same latitude and calls particular attention to the circumstance that although the climate may be identical over these widely separated areas, the species and higher groups are totally distinct, because the regions have been disconnected since early geologic times—as if these facts were not self-evident. On the other hand, in single continental areas where there is no break or barrier of any kind between widely different faunal zones, he tries to invent some unnatural reason for the differences observed and is reluctant to admit that even in these cases climate or climatic conditions can constitute the barriers to dispersion that undoubtedly exist. He says of climate: "Probably its action is indirect, and is determined by its influence on vegetation, and by bringing diverse groups into competition."

In another place he states: "Hot countries usually differ widely from cold ones in all their organic forms; but the difference is by no means constant, nor does it bear any proportion to difference of temperature. Between frigid Canada and subtropical Florida there are less marked differences in the animal productions than between Florida and Cuba or Yucatan, so much more alike in climate and so much nearer together." He states further: "The eastern United States possess very peculiar and interesting plants and animals, the vegetation becoming more luxuriant as we go south but not altering in essential character; so that when we reach the southern extremity of Florida we still find ourselves in the midst of oaks, sumacs, magnolias, vines, and other characteristic forms of the temperate flora; while the birds, insects, and land-shells are almost identical with those found further north. But if we now cross over the narrow strait, about fifty miles wide, which separates Florida from the Bahama Islands, we find ourselves in a totally different country, surrounded by a vegetation which is essentially tropical and generally identical with that of Cuba. The change is most striking, because there is no difference of climate, of soil, or apparently of position, to account for it." (Island Life, 1880, p. 5.)

Let us examine this statement with some care to see if the facts warrant the assertions and conclusions of the author. But first let me protest against Wallace's habit of contrasting insular faunas with those of continuous land areas, in his efforts to minimize the effects of climate. In most cases the great majority of

forms peculiar to an island have no means of reaching the nearest continuous land, but in the present instance, as will be shown later, the proximity of Cuba and the Bahamas to Florida, favored by the direction of the Gulf Stream and the prevalence of hurricanes blowing from the Antilles to the Peninsula, have enabled a multitude of West Indian plants, insects, birds, and even land-shells to reach southern Florida, though the breadth of the strait is an effective bar to the passage of terrestrial mammals and reptiles.

Wallace boldly tells us, without attempt at qualification, that "between frigid Canada and sub-tropical Florida there are less marked differences in the animal productions than between Florida and Cuba." Frigid Canada, in eastern North America, is the home of the Eskimo, polar bear, musk oxen, reindeer, lemmings, marmots, beavers, muskrats, porcupines, wolverines, sables, shrews, star-nosed moles, and several other mammals, comprising in all 20 genera, not one of which occurs in southern Florida.* Florida, on the other hand, is inhabited by opossums, harvest mice, rice-field mice, cotton rats, wood rats, pocket gophers, gray foxes, spotted skunks, big-eared bats, and other forms, representing 13 genera and 5 families of mammals that do not occur in frigid Canada†. In the case of birds, eastern Canada has 26 genera that do not reach Florida, among which may be mentioned ptarmigans, grouse, rough-legged hawks, golden eagles, great gray owls, snowy owls, Acadian owls, hawk owls, three-toed woodpeckers, Canada jays, pine bullfinches, crossbills, linnets, snow buntings, titlarks, winter wrens, kinglets, and stone chats,‡ while Florida has at least 37 genera that do

*The following 20 genera of mammals inhabit eastern Canada, but none of them reach southern Florida: *Rangifer, Alce, Oribos, Tamias, Spermophilus, Arctomys, Castor, Fiber, Arvicola, Evotomys, Phenacomys, Myodes, Cuniculus, Zapus, Erethizon, Thalarctos, Gulo, Mustela, Condylura, Scapanus, Sorex.*

†The following 13 genera of mammals inhabit Florida, but none of them reach "frigid Canada:" *Didelphis, Reithrodontomys, Oryzomys, Sigmodon, Neotoma, Geomys, Urocyon, Procyon, Spilogale, Corynorhinus, Nycticejus, Nyctinomus, Otopterus.* The 5 families are: *Didelphida, Geomyida, Procyonida, Emballonurida, Phyllostomatida.*

‡The following 26 genera of birds breed in eastern Canada, but none of them in Florida: *Dendragapus, Bonasa, Lagopus, Archibuteo, Aquila, Scotiaptex, Nyctala, Nyctea, Surnia, Picoides, Sphyrapicus, Perisoreus, Dolichonyx, Piniola, Loxia, Acanthis, Plectrophenax, Calcarius, Zonotrichia, Junco, Passerella, Anthus, Anorthura, Certhia, Regulus, Saxicola.*

not reach Canada, among which are quails, turkeys, doves of several genera, vultures, caracaras, kites, barn and burrowing owls, parrots, anis, ivory-billed woodpeckers, chuck-wills-widows, cardinals, blue grosbeaks, yellow-breasted chats, mocking birds, and others.*

Thirty out of the above 37 genera breed also in the West Indies.

No less than nine Tropical American genera of birds inhabit the subtropical belt of Florida, namely, *Zenaida*, *Geotrygon*, *Starnænas*, *Rostrhamus*, *Polyborus*, *Crotophaga*, *Euethia*, *Callichelidon*, and *Cereba*. The following Antillean species and subspecies occur in the same area and are not known from any point further north: *Colinus virginianus cubanensis*, *Columba leucocephala*, *Zenaida zenaida*, *Geotrygon martinica*, *Starnænas cyanocephala*, *Rostrhamus sociabilis*, *Falco dominicensis*, *Speotyto cunicularia floridana*, *Polyborus cheriway*, *Crotophaga ani*, *Coccyzus minor maynardi*, *Agelaius phœniceus bryanti*, *Euethia bicolor*, *Euethia canora*, *Progne cryptoleuca*, *Petrochelidon flava*, *Callichelidon cyanoviridis*, *Vireo altiloquus barbatulus*, *Cereba bahamensis*. In addition to these species, the following are restricted, so far as known, to southern Florida: *Meleagris gallopavo osceola*, *Chordeiles virginianus chapmani*, *Cyanocitta cristata florincola*, *Ammodramus nigrescens*, *Vireo noveboracensis maynardi*, *Geothlypis trichas ignota*, *Thryothorus ludovicianus miamensis*, *Cistothorus mariannæ*, *Sitta carolinensis atkinsi*.

That there are corresponding differences among insects is evident from an important paper by Mr. E. A. Schwarz on the Insect Fauna of Semitropical Florida. Mr. Schwarz states: "I have come to the conclusion that it [the semitropical fauna of Florida] is entirely of West Indian origin, and that the region I shall hereafter circumscribe as Semitropical Florida does not contain any endemic forms. In other words, the distinctive fauna of southern Florida is a permanent colony of West Indian forms, much more numerous in species than it has

*The following 37 genera of birds breed in Florida, but none of them range north to "frigid Canada," though 30 out of the 37 are known to breed in the West Indies: *Colinus*, *Meleagris*, *Columba*, *Zenaidura*, *Zenaida*, *Columbigallina*, *Geotrygon*, *Starnænas*, *Cathartes*, *Catharista*, *Elanoides*, *Elanus*, *Ictinia*, *Rostrhamus*, *Polyborus*, *Strix*, *Speotyto*, *Conuras*, *Crotophaga*, *Campephilus*, *Antrostomus*, *Aphelocoma*, *Icterus*, *Pencæa*, *Pipilo*, *Cardinalis*, *Guiraca*, *Euethia*, *Certhiola*, *Protonotaria*, *Helinaia*, *Helmitherus*, *Icteria*, *Mimus*, *Harporhynchus*, *Thryothorus*, *Polioptila*.

hitherto been supposed, the number in *Coleoptera* alone amounting, according to a very low estimate based upon my collection, to at least 300 species not yet in our catalogues." (Entomologica Americana, IV, No. 9, 1888.) Since the above was published, Mr. Schwarz has had the kindness to inform me that this semitropical insect fauna of southern Florida comprises in all not less than 1,000 species of West Indian or Antillean insects (of which about half are *Coleoptera*), and 50 genera of *Coleoptera* and *Heteroptera* alone;* hence the total number of genera must be very considerable.

Among the Mollusca, Dr. Wm. H. Dall informs me that 20 species or specific types of Antillean land shells are known to inhabit southern Florida, representing 13 genera or subgenera not found further north.†

So far as vegetation is concerned, the case is even stronger, there being upwards of 350 genera of plants in Florida that do not inhabit Canada; and Professor Charles S. Sargent, in speaking of the trees of southern Florida, states: "A group of arborescent species of West Indian origin occupies the narrow strip of coast and islands of southern Florida. * * * This semitropical forest belt reaches Cape Malabar on the east coast and the shores of Tampa Bay on the west coast. * * * The species of which it is composed here reach the extreme northern limit of their distribution; they are generally small, stunted, and of comparatively little value. Certain species, however, attain re-

*Mr. Schwarz has kindly given me the following list of families of Central American Coleoptera, indicating the number of genera in each family known to inhabit Semitropical Florida, but not found elsewhere in North America: *Carabidæ*, 2 genera; *Phalacridæ*, 1; *Coccinellidæ*, 1; *Cucujidæ*, 1; *Mycetophagidæ*, 1; *Elateridæ*, 1; *Scarabæidæ*, 2; *Cerambycidæ*, 5; *Chrysomelidæ*, 4; *Tenebrionidæ*, 3; *Monommidæ*, 1; *Otiorhynchidæ*, 1; *Curculionidæ*, 6; *Brenthidæ*, 1 [this is the only genus which reappears at Cape San Lucas]; *Calandridæ*, 3; *Scolytidæ*, 3; *Anthribidæ*, 2. He informs me also that 11 genera of Tropical American Heteroptera have been found in the same belt.

†The forms here referred to are: *Strobila hubbardii* Brown; *Helix cæca Helix varians* Mke.; *Bulimulus multilineatus* Say; *Bulimulus dormani* W. G. B.; *Orthalicus undatus* Brug; *Liguus fasciatus* Müller; *Liguus fasciatus* var. *Stenogyra gracillima* Pfr.; *Stenogyra subula* Pfr.; *Macrocyrtus gossei* Pfr.; *Macrocyrtus pontificus* Gld. (also occurs in Texas); *Strophia incana* Binn.; *Auricula pellucens* Mke.; *Tralia minuscula* Dall; *Melampus* (*Detracia*) *bulloides* Mont.; *Pedipes mirabilis* Muhlf.; *Pedipes elongatus* Dall; *Planorbis tumidus* Pfr.; *Spharium cubense* Morelet.

spectable proportions: the mahogany, the mastic, the royal palm, the mangrove, the sea-grape, the Jamaica dogwood, the manchineel, and other species here become considerable and important trees." (Forests of North America, 10th Census, 1884, p. 6.)

From what has been said it appears not only that Wallace's statement that "between frigid Canada and subtropical Florida there are less marked differences in the animal productions than between Florida and Cuba" is wholly incorrect, but that there exists in Florida a well marked subtropical fauna and flora consisting in the main (except in the case of terrestrial mammals and reptiles which could not reach it) of genera, and largely of species, identical with those of Cuba. This being the case, is it not fair to turn the tables and ask Wallace what constitutes the barrier that so effectually holds back hundreds of genera and a multitude of species of Antillean or Tropical American plants, insects, land mollusks, and birds now inhabiting subtropical Florida? The deep arm of ocean between Florida and Cuba or the Bahamas has proved ineffectual in checking their dispersion. What is the more potent barrier that prevents their northward spread along the continuous land of the peninsula? The answer is summed up in the single word *climate*. The temperature of the period of growth and reproduction in the northern parts of Cuba and the Bahamas is the same as in subtropical Florida, but to the northward it falls off rapidly.

Respecting Wallace's statement that the difference between the faunas and floras of hot and cold countries "is by no means constant," and does not bear "any proportion to difference of temperature," it need only be said that no phenomenon of nature is more constant, and that the differences observed depend directly upon temperature. President D. S. Jordan has said: "In many groups anatomical characters are not more profound or of longer standing than are the adaptations to heat and cold." (Popular Science Monthly, XXXVII, Aug., 1890, p. 506.)

That "life is distributed in circumpolar zones, which conform with the climatic zones, though not always with the parallels of the geographer" is a law recognized by Humboldt, Wagner, Agassiz, Dana, De Candolle, Allen, and nearly all writers on distribution except Wallace. This law does not imply that the same species, genera, or higher groups recur under the same

degree of heat in disconnected land areas—a manifest impossibility—but that well marked zones of animal and plant life are encountered in all parts of the earth in passing from the poles to the tropics: that they owe their existence to constant differences of temperature, and that in continuous land areas each zone may be traced completely across such areas [from ocean to ocean in those of continental magnitude], following the windings of the belts of equal temperature during the period of reproductive activity.

Wallace speaks thus of this law as formulated by Allen: "The author [J. A. Allen] continually refers to the '*law of the distribution of life in circumpolar zones*,' as if it were one generally accepted and that admits of no dispute. But this supposed 'law' only applies to the smallest detail of distribution—to the range and increasing or decreasing numbers of *species* as we pass from north to south, or the reverse; while it has little bearing on the great features of zoological geography—the limitations of groups of *genera* and *families* to certain areas." (Geog. Dist. of Animals, vol. I, 1876, p. 67). Mr. Allen has already pointed out the weakness of this criticism (Bull. U. S. Geol. and Geog. Survey Terr., vol. IV, No. 2, May, 1878, 326), and I would like to add a word respecting the extraordinary statement that circumpolar distribution affects *species* only, having "little bearing" on the "limitations of groups of genera and families." In refutation of this fallacy it is hardly necessary to do more than call attention to the circumstance that the transcontinental Sonoran region of North America is distinguished from the Boreal by the possession of 7 families and 34 genera of mammals alone,* and the North American Tropical from the Sonoran by 10 families and upwards of 50 genera; while the American Boreal differs from the Eurasian Boreal by the possession of but a single family and only 8 genera.

*These genera are: *Didelphis, Dicotyles, Cariacus, Antilocapra, Cynomys, Reithrodontomys, Onychomys, Oryzomys, Sigmodon, Neotoma, Geomys, Thomomys, Dipodomys, Perodipus, Microdipodops, Perognathus, Heteromys, Felis, Urocyon, Procyon, Bassariscus, Taxidea, Conepatus, Mephitis, Spilogale, Notiosorex, Scalops, Corynorhinus, Euderma, Antrozous, Nyctinomus*, and *Otopterus*. Five of these genera have each a species reaching a short distance into the southern edge of the Boreal Region, namely, *Cariacus, Neotoma, Felis, Procyon*, and *Mephitis*.

Mountains as Barriers to Dispersion.

Wallace makes the surprising statement that on the two sides of the Rocky Mountains in America "almost all the mammalia, birds, and insects are of distinct species"*—a statement that is wholly untrue, as has been long known to American naturalists. In another place he makes the general statement that mountains, "when rising to a great height in unbroken ranges, form an impassable barrier to many groups." No instance of this kind is known in North America. Even in the High Sierra in California nearly all of the families, genera, and species occur on the east slope as well as on the west, notwithstanding the great altitude this lofty range maintains for a considerable distance.† The explanation of the similarity or identity of the species on the two sides of all our mountain systems is that similar or identical climatic zones occur on both sides, between which avenues of communication exist or have existed by means of passes, either through the ranges themselves or at one end or the other. In their continuity, however, lofty mountain ranges do act as barriers to the spread of species from lower levels, but they do so *indirectly* by their effects upon climate—by interposing an arctic zone in which the species of lower latitudes cannot live. On the other hand, this same arctic-alpine climate enables many polar species to thrive in regions two or three thousand miles south of their normal continental homes.

The great Himalaya has little or no influence in bringing about the really enormous differences that exist between the faunas and floras of the plains on its two sides, for these dissimilarities are due primarily to the great difference of temperature resulting from unequal base-level, the Thibetan plateau on the north being several thousand feet higher than the plain on the south.

The so-called Eastern, Central, and Western Provinces and the evidence on which they are based.

Wallace, in common with most recent writers, divides the United States into Eastern, Central or Rocky Mountain, and

* Geog. Dist. of Animals, I, 1876, p. 6.

† For 320 kilometers (200 miles) the Sierra Nevada Mountains maintain an elevation of 3,100 to 4,600 meters (12,000 to 15,000 feet).

Pacific or Californian 'subregions.' He admits that the Eastern division is characterized by but a single mammalian genus, namely, the star-nosed mole (*Condylura*).

In characterizing the so-called Central or Rocky Mountain subregion, he states that the prong-horned antelope, the mountain goat, the mountain sheep, and the prairie dog are peculiar to it, forgetting that the antelope ranges from the Mexican plateau northward over the Great Plains and Great Basin, and westward over much of California; that the mountain goat inhabits British Columbia and the Cascade Range as well as the Rocky Mountains; that the mountain sheep is common in the High Sierra in California and ranges northward to the Arctic Circle in Alaska; leaving the prairie dog as the only one confined to the region.

The Pacific or 'Californian subregion' he defines as "the comparatively narrow strip of country between the Sierra Nevada and the Pacific. To the north it may include Vancouver's Island and the southern part of British Columbia." Under the head of the mammalia of this area, he enumerates 8 genera as "not found in any other part of the Nearctic region," namely, *Macrotus*, *Antrozous*, *Crotrichus*, *Neosorex*, *Bassaris*, *Enhydra*, *Moronga*, and *Haploodon*. A more erroneous statement could hardly be made. Of the two pelagic genera, *Moronga* and *Enhydra* [= *Lutax*], the former does not enter the region at all and the latter barely reaches it: while of the non-pelagic genera three, *Macrotus* [= *Otopterus*], *Antrozous*, and *Bassaris* [= *Bassariscus*], range over the Sonoran region from Texas and the Mexican plateau across New Mexico, Arizona, and parts of southern Nevada and California: and the subgenus *Neosorex* occurs over pretty much the whole of Boreal America from the Atlantic to the Pacific. The two remaining genera only are confined to the Californian division, namely, *Crotrichus* [= *Neurotrichus*] and *Haploodon* [= *Aplodontia*]. Both are isolated types, inhabiting the Pacific coast country from northern California to British Columbia (the latter having no near relative in any part of the world, the former closely related to genera now living in Eastern Asia).

Hence it appears, so far as the mammalia are concerned, that these three supposed primary subdivisions of North America rest upon a misconception of fact, the *Californian* division possessing two peculiar genera, and the *Eastern* and *Central* divisions but a single peculiar genus each—a quantity of difference it would be absurd to recognize as of sufficient weight to warrant the erection of zoogeographical divisions.

In a communication already referred to (North American Fauna, No. 3, September, 1890) I stated the conclusion that the commonly accepted division of the United States into Eastern, Middle, and Western Provinces had no existence in nature, and that "the whole of extratropical North America [the Nearctic region of Sclater and Wallace] consists of but two primary life regions, a *Boreal* region, which is circumpolar; and a *Sonoran* or *Mexican Table-land* region which is unique." The so-called Eastern Province is mainly of Sonoran derivation, comprising the humid divisions of the Lower Sonoran and Upper Sonoran Zones (Austroriparian and Carolinian faunas), and of the Transition or Neutral Belt commonly known among ornithologists as the Alleghanian fauna. It contains also a southward extension of the Boreal Region along the Appalachian mountain system—mainly in the form of isolated islands.

The so-called Central Region in like manner is made up of a southward extension of the Boreal Region along the Rocky Mountain plateau, enclosed between two northward prolongations of the arid Sonoran, the one occupying the Great Plains, the other the Great Basin.

The so-called Pacific or Western Province consists of a southward extension of the Boreal Region which finally bifurcates, sending a long arm south over the Cascade Range and the Sierra Nevada, and a secondary and shorter arm along the Pacific coast north of San Francisco, together with a Sonoran element which covers nearly the whole southern part of the state and reaches north in the San Joaquin and Sacramento Valleys.

Palearctic and Nearctic Regions.

It is no part of the purpose of the present address to discuss the distribution of life outside of our own continent, but it so happens that the Boreal element in America resembles that of Eurasia so closely that in the judgment of many eminent authorities the two constitute but a single primary region—a view in which I heartily concur. This arrangement is antagonistic to that proposed by Sclater* in 1857 and adopted with slight modification by Wallace. Sclater considers the whole of extratropical North America as constituting a single region,

*Journ. Linn. Soc. (Zool.), II (for 1857), 1858, 130–145; and again, with some alterations, in Ibis, sixth series, III, 1891, 514–557.

upon which he bestowed the name *Nearctic*, in contradistinction to the corresponding part of Eurasia, which he named *Palæarctic*, believing the two to be distinct primary regions.

Wallace, the great champion of Sclater's Palæarctic and Nearctic regions, says of the former in his most recent work on geographic distribution: "Taking first the mammalia, we find this region is distinguished by its possession of the entire family of *Talpidæ* or Moles, consisting of 8 genera and 16 species, all of which are confined to it except one which is found in Northwest America, and two which extend to Assam and Formosa." (Island Life, 1880, 41.) How he could have made such an erroneous statement is hard to understand, in view of the well-known fact that three genera of moles inhabit eastern North America and two the Pacific coast region; and it is the more strange since on another page of the same work he states that there are three peculiar genera of moles in North America.*

He states further: "Among carnivorous animals the lynxes (9 species) and the badgers (2 species) are peculiar to it [the Palæcrctic region] in the old world, while in the new the lynxes are found only in the colder regions of North America" (Island Life, 1880, 41), thus implying that there are no badgers in North America, and ignoring the presence of lynxes all along the southern border of the United States from Florida and Texas to southern California. Continuing, he mentions a number of groups which, he says, "have only a few species elsewhere." Among these are the "voles, dormice, and pikas." Pikas inhabit the mountains of western Canada and range south in the Cascades and High Sierra to southern California, and in the Rocky Mountains to Colorado. They have been reported also from the high mountains of Lower California in Mexico. The group of voles or *Arvicolinæ*, exclusive of the lemmings, is represented in Boreal North America by not less than 4 genera, 5 subgenera, and nearly 50 species. It is only fair to add, however, that some of these have been described since Wallace's book was written

"The Nearctic region is so similar to the Palæarctic in position

*In his earlier work he says: "*Condylura* (1 species), the star-nosed mole, inhabits eastern North America from Nova Scotia to Pennsylvania; *Scapanus* (2 species) ranges across from New York to San Francisco; *Scalops* (3 species), the shrew moles, range from Mexico to the Great Lakes. * * * *Urotrichus* is a shrew-like mole which inhabits Japan, and a second species has been discovered in the mountains of British Columbia." (Geog. Dist. of Animals, II, 1876, 190.)

and climate," he admits, "and the two so closely approach each other at Bering Strait, that we cannot wonder at there being a certain amount of similarity between them—a similarity which some naturalists have so far overestimated as to think that the two regions ought to be united." After enumerating a number of mammals common to the two he goes on to say: "We undoubtedly find a very close resemblance between the two regions, and if this were all, we should have great difficulty in separating them. But along with these we find another set of mammals, not quite so conspicuous but nevertheless very important. We have first, three peculiar genera of moles, one of which, the star-nosed mole, is a most extraordinary creature, quite unlike anything else. Then there are three genera of the weasel family, including the well-known skunk (*Mephitis*), all quite different from eastern forms. Then we come to a peculiar family of carnivora, the raccoons, very distinct from anything in Europe or Asia: and in the Rocky Mountains we find the prong-horned antelope (*Antilocapra*) and the mountain goat of the trappers (Aplocerus [=*Mazama*]), both peculiar genera. Coming to the rodents, we find that the mice of America differ in some dental peculiarities from those of the rest of the world, and thus form several distinct genera; the jumping mouse (*Zapus* [=*Zapus*]) is a peculiar form of the jerboa family; and then we come to the pouched rats (*Geomyidæ*), a very curious family consisting of four genera and nineteen species, peculiar to North America, though not confined to the Nearctic region. The prairie dogs (*Cynomys*), the tree porcupine (*Erethizon*), the curious sewellel (*Haplodon* [=*Aplodontia*]), and the opossum (*Didelphis*) complete the list of peculiar mammalia which distinguish the northern region of the new world from that of the old." (Island Life, p. 48.)

As already shown in an earlier part of the present essay, most of these genera and several of the families belong to the austral or Sonoran region and have no place in the Boreal fauna—the only one that can be compared with the fauna of northern Eurasia. As a matter of fact, 81 genera of non-pelagic mammals are now recognized in 'extratropical' North America—the so-called Nearctic Region. Of this number 41 are found in no other part of the world.* These genera are enumerated in the follow-

*The intrusive genera *Didelphis*, *Tatusia*, *Dicotyles*, *Procyon*, *Nasua*, and *Molossus*, which are clearly of South American origin, are not here included.

ing table, which brings out the important fact that no less than 32, or 78 percent, are of Sonoran or austral origin, while only 9, or 22 percent, are of Boreal origin. Of these 9 genera now confined to North America, *Ovibos* inhabited polar Eurasia in Pleistocene times; *Neurotrichus* is not recognized by Flower and Lydekker as more than subgenerically separable from *Urotrichus* of Japan, and *Synaptomys* is not known except from the Transition Zone of the United States and is here classed as Boreal because of its close relationship to the transcontinental Boreal genus *Myodes*. Omitting these three, Boreal North America has but 6 genera of mammals not known from Boreal Eurasia.

Peculiar Genera of Mammals inhabiting North America north of Mexico

Of Boreal Origin

Mazama	Zapus
Ovibos	Erethizon
Aplodontia	Neurotrichus
Fiber	Condylura
Synaptomys	

Of Sonoran Origin

Cariacus	Urocyon
Antilocapra	Bassariscus
Cynomys	Taxidea
Reithrodontomys	Conepatus
Sitomys	Mephitis
Oryzomys	Spilogale
Onychomys	Notiosorex
Sigmodon	Scalops
Neotoma	Scapanus
Thomomys	Blarina
Geomys	Antrozous
Dipodomys	Nycticejus
Perodipus	Otopterus
Microdipodops	Corynorhinus
Perognathus	Euderma
Heteromys	Atalapha

On the other hand, out of the 31 Boreal genera of North American mammals the following 24 genera, or 77 percent, are common to Boreal America and Boreal Eurasia:

Cervus	Cuniculus
Rangifer	Lagomys
Alce	Vulpes
Ovis	Ursus
Bison	Thalarctos
Tamias	Latax
Arctomys	Lutreola
Castor	Putorius
Phenacomys	Mustela
Evotomys	Gulo
Arvicola	Sorex
Myodes	Urotrichus*

In addition to the foregoing genera, which are clearly of Boreal origin, the following 12 genera of more extended range are also common to the two continents:

Sciuropterus	Felis
Sciurus	Lynx
Spermophilus	Vesperugo
Lepus	Vespertilio
Canis	Plecotus†
Lutra	Nyctinomus

Most of these genera are known to be of great antiquity, their remains having been found in Miocene strata, and it is probable that the others belong to the same category, but have thus far escaped detection, owing to their very small size. All of them attain their maximum development and numbers in the Sonoran Region in America and the analogue of the Sonoran in Eurasia; but by reason of the great length of time that has elapsed since they came into existence some of their representatives have become acclimated to a wide range of climatic conditions.

Dr. John L. Le Conte, in his report on the Coleoptera of Lake Superior, said: "The entomologist cannot fail to be struck with two very remarkable characters displayed by the insect fauna of these northern regions. First, the entire absence of all those groups which are *peculiar* to the American continent [*i. e.*, Sonoran and Tropical groups]. * * * The few new genera which

*As stated above, Flower and Lydekker do not recognize the American animal as generically distinct from *Urotrichus*. While I agree with Dobson in according it generic rank, it is convenient, in studying the origin of groups, to bring together such closely related types.

†The American species of *Plecotus* are separated generically by Dr. Harrison Allen under the name *Corynorhinus*, which is adopted by the writer. The more comprehensive name *Plecotus* is here used for the reason just stated under *Urotrichus*.

I have ventured to establish are not to be regarded as exceptions. They are all closely allied to European forms, and by no means members of groups exclusively American.

"Secondly, the deficiency caused by the disappearance of characteristic forms is obviated by a large increase of the members of genera feebly represented in the more temperate regions, and also by the introduction of many genera heretofore regarded as confined to the northern part of Europe and Asia. Among these latter are many species which can be distinguished from their foreign analogues only by the most careful examination. This parallelism is sometimes most exact, running not merely through the genera, but even through the respective species of which they are composed." (Lake Superior, 1850, 239–240.)

W. F. Kirby, in a paper 'On the Geographical Distribution of the Diurnal Lepidoptera as compared with that of Birds,' states: "Had I been dealing with Lepidoptera only, I would certainly have united Dr. Sclater's 'Palæarctic Region' and 'Nearctic Region;' for although the species of North American Rhopalocera are seldom identical with those of northern Asia and Europe, still the genera are the same with scarcely an exception, except a few representatives of South American genera, which have no more right to be considered Nearctic species than the similar chance representatives of African forms in North Africa or Southwest Europe, or of Indian forms in Southeast Europe, have to be considered Palæarctic species." (Journ. Linnean Soc. London, Zool. 1873, 432.)

It now becomes evident that the so-called Palæarctic and Nearctic regions are the result, in each case, of confounding and combining two wholly distinct regions—the Boreal with the Sonoran in America and the Boreal with the analogue of the Sonoran in Eurasia. Eliminating these austral elements as wholly foreign to the region to which they have been so persistently attached, there remains a single great Circumpolar Boreal region characterized by a remarkably homogeneous fauna, covering the northern parts of America and Eurasia.

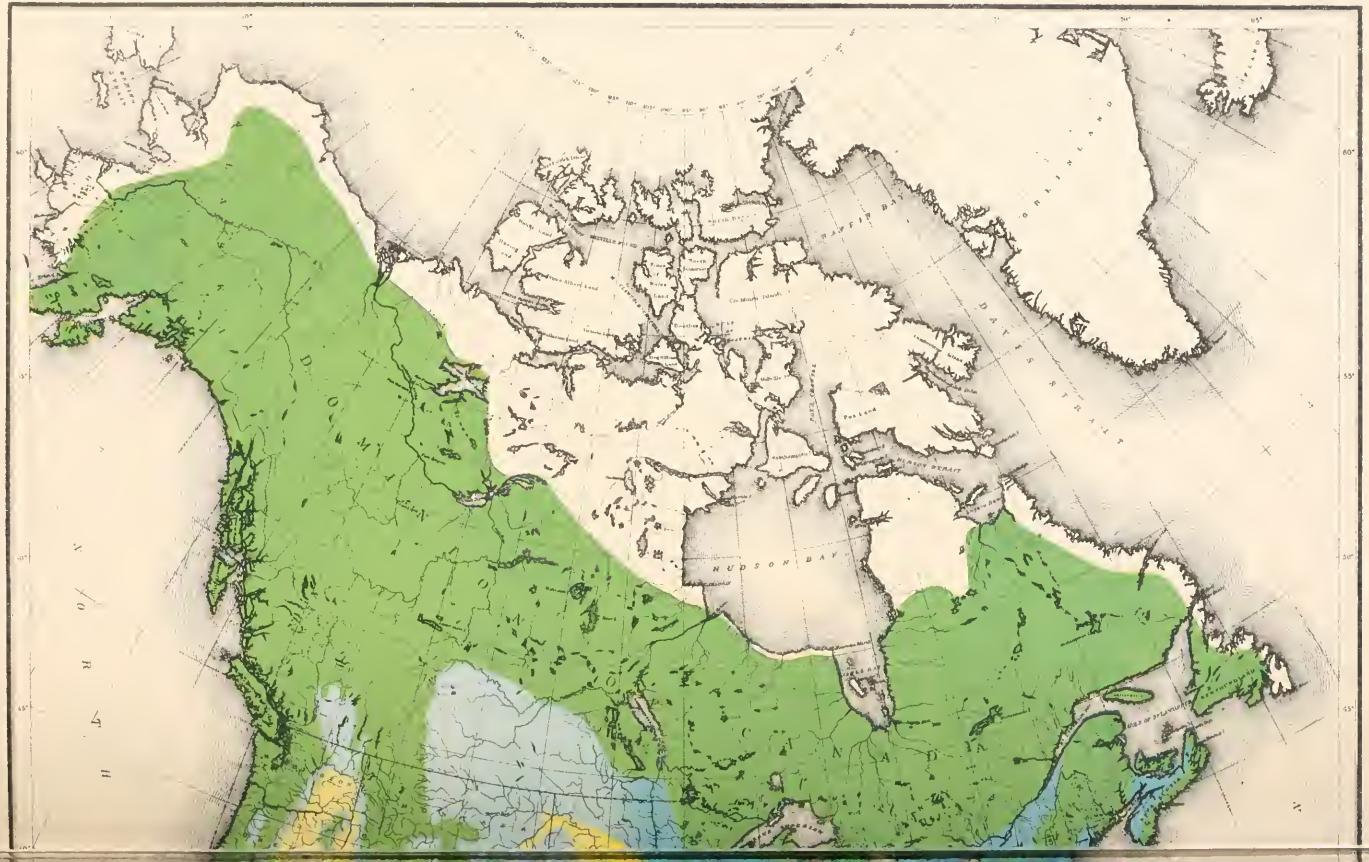
Cope has shown that the chief differences between Boreal America and Boreal Eurasia are found among the fishes and batrachians—animals living wholly or in part in water. Now it cannot be insisted too strongly that while the chief factor in the distribution of aquatic animals and plants is temperature, as has been long acknowledged, yet from the very nature of the case the resulting life regions must be different—the one supple-

menting or being the complement of the other—for water being the medium in which the species live, the bodies of water with their prolongations and extensions, as bays, rivers, and lakes, must be studied as entities, just as we study a continent with its peninsulas and outlying islands—the means of access to a given body of water being the principal factor in determining the water-area to which its aquatic life belongs. And it should be remarked that aquatic mammals, as seals and cetaceans, and aquatic birds, as ducks and gulls, conform in the main to the laws and areas of aquatic distribution and should not be taken into account in studying the distribution of terrestrial forms of life.

Gill has said with much truth: "There appears to be a total want of correlation between the inland and marine faunas, and a positive incongruity, and even contrast, between the two." (Proc. Biol. Soc. Wash., II, 1884, 32.)

Principles on which Bio-Geographic Regions should be established.

Wallace, in writing of the principles on which Zoological regions should be formed, expresses the opinion that "convenience, intelligibility, and custom, should largely guide us." But I quite agree with America's most distinguished and philosophic writer on distribution, Dr. J. A. Allen, that in marking off the life regions and subregions of the earth, truth should not be sacrificed to convenience; and I see no reason why a homogeneous circumpolar fauna of great geographic extent should be split up into primary regions possessing comparatively few peculiar types simply because a water separation happens to exist in the present geologic period; nor is it evident why one of the resulting feeble divisions should be granted higher rank than a region of much less geographic extent comprising several times as many peculiar types. Hence the divisions here recognized, and the rank assigned them, are based as far as possible upon the relative numbers of distinctive types of mammals, birds, reptiles, and plants they contain, with due reference to the steady multiplication of species, genera, and higher groups from the poles toward the tropics. Mammals have been chiefly used as illustrations because they answer the purpose better than any other single group, and because it is clearly impossible in a brief essay of this character to enumerate such a multitude of forms as would be necessary were equal consideration accorded to each class.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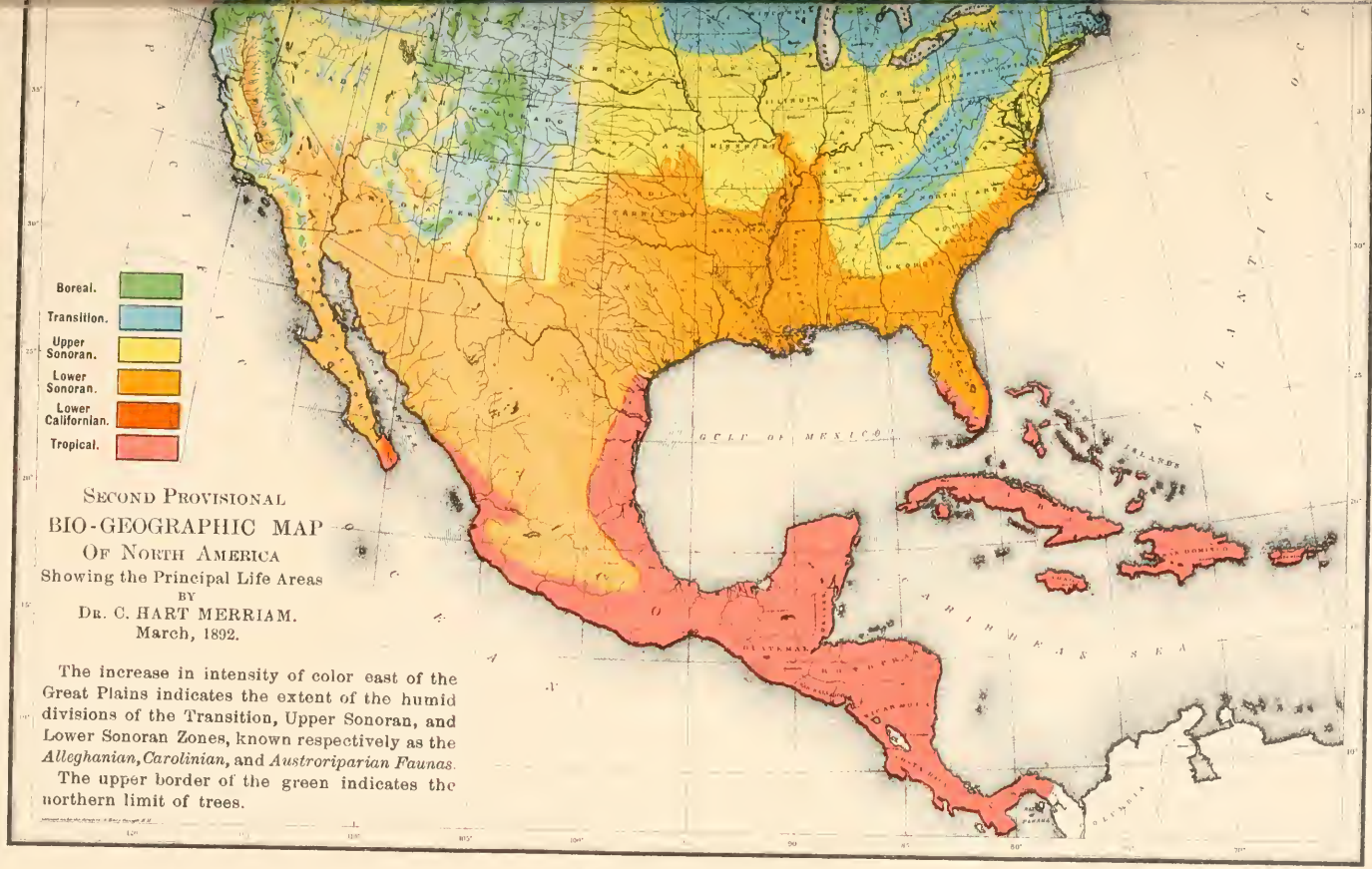

SECOND PROVISIONAL

BIO-GEOGRAPHIC MAP

OF NORTH AMERICA

Showing the Principal Life Areas

BY

DR. C. HART MERRIAM.

March, 1892.

The increase in intensity of color east of the Great Plains indicates the extent of the humid divisions of the Transition, Upper Sonoran, and Lower Sonoran Zones, known respectively as the *Alleghanian, Carolinian,* and *Austroriparian Faunas.*

The upper border of the green indicates the northern limit of trees.

Photo-Lith by A. HORN & CO. Berlin, W.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

DESCRIPTIONS OF NEW PLANTS FROM SOUTHERN CALIFORNIA, NEVADA, UTAH, AND ARIZONA.

BY FREDERICK VERNON COVILLE.*

In January, 1891, an expedition was sent out by the United States Department of Agriculture to make a biological survey of Death Valley, in southeastern California, and the adjacent regions. As several months must elapse before the report on the botany of the expedition can be presented to the public, the following descriptions of new plants are now published with the consent of the department authorities.

Aplopappus interior sp. nov.

Related to *A. linearifolius* DC., but differing in its shorter leaves (12 to 20 mm.), subulate-bracteate peduncles, shorter acute involucral bracts, and smaller rays 9 to 11 mm. long. In *A. linearifolius* the larger leaves are 30 to 40 mm. long, the peduncles leafy-bracted, the involucral bracts 11 to 14 mm. long, including the filiform-subulate acumination, and the rays 13 to 15 mm. long.

Type specimen in the United States National Herbarium, No. 794, Death Valley Expedition; collected May 20, 1891, about four miles southeast from Mill Cañon divide, at the northern

* Presented at a meeting of the Biological Society of Washington, April 16, 1892.

edge of the Darwin Mesa, Inyo County, California, by Frederick V. Coville.

A. linearifolius, first collected in California by Douglas, probably near San Francisco or Monterey, is known only from the coast ranges southward from San Francisco bay. *A. interior* is a species of the desert mountains, and has been collected in the higher elevations of the Lower Sonoran region from southern Utah, northwestern Arizona, and Inyo County, California, southward to the extra-coastal region of San Diego County.

Arctomecon merriami sp. nov.

Plant apparently perennial, from a thick woody root, branching into a broad cæspitose tuft 10 cm. or less high; leaves cuneate-oblanceolate, 2 to 3 cm. long, tapering below into a margined petiole, tridentate at the truncate apex, glaucous, clothed with very long (about 1 cm.), white, spreading, flexuous, barbellate hairs; upper leaves sessile, often entire and acute or obtuse at the apex; peduncles several, erect, 20 to 35 cm. high, glabrous, glaucous, rarely with a bract (similar to the leaves) below; flower single, in bud inclined to nod; sepals usually 3, hairy like the leaves, caducous; petals usually 6, white, obcordate, 3 to 3.5 cm. long, deciduous; stamens very numerous; anthers 3 to 4 mm. long when wet; filaments slender, glabrous, some of them conspicuously broader above; ovary narrowly oblong, 1-celled, with 6 or 7 parietal placentæ; style about 1.5 mm. long and broad; stigma capitate and with a stigmatic line opposite each placenta; capsule linear-oblong, in our specimens 3.5 to 4.1 cm. long; valves splitting down at the apex for a distance of 8 mm.; seeds not seen.

Type specimen in the United States National Herbarium, No. 1890, Death Valley Expedition; collected May 1, 1891, a few miles west of Vegas ranch, Lincoln County, Nevada, by C. Hart Merriam and Vernon Bailey.

This plant differs from *A. californicum* it its usually 1-flowered bractless peduncles, long-hairy sepals, white petals, longer dilated filaments, linear-oblong ovary and capsule (4 cm. long), and evident style. *A. californicum* has, on the other hand, 6- to 20-flowered, leafy-bracted peduncles, glabrous sepals, deep yellow petals, filaments of uniform width, obovoid ovary, sessile stigma, and an ovate capsule about 1.5 cm. long.

This beautiful poppy is dedicated to Dr. C. Hart Merriam as a token of his influence in the progress of geographic botany.

Arctomecon humile sp. nov.

In 1874 Dr. C. C. Parry collected in the vicinity of St. George, Utah, an *Arctomecon*, which Dr. Gray referred* to *A. californicum*. The material now in hand shows that it is distinct both from the original plant of Fremont and from the species just described. It differs from the former in its smaller size throughout, less hairy leaves, fewer flower parts, white petals, dilated filaments, and the presence of a style; from *A. merriami* in its smaller size and more scanty hairs, more than 1-flowered peduncles, fewer flower parts, persistent petals, and obovate, several times shorter capsule.

Type specimen in the Harvard Herbarium.

The genera *Canbya* and *Arctomecon* are described† as distinguishable by their stigmas; in the former opposite the placentæ, in the latter opposite the valves. In *Arctomecon merriami* the capitate stigma is evidently made up of as many parts or lobes as there are placentæ, and each of these parts is directly opposite a valve. Along both lateral margins of each lobe are stigmatic lines, and the union of the two contiguous ones, of adjacent lobes, makes a stigmatic line opposite the placenta. There is nothing in *Canbya* to show that the stigmatic line, which is there also opposite the placenta, was not derived in the same way; yet the two genera are sufficiently characterized by their general differences.

Arenaria compacta sp. nov.

Stems compacted into a dense mat from a thick, woody, many-branched caudex, the densely leafy lower portion 1 cm. or less high; flowering stems scantily leafy, sparingly cymosely branched, 5 cm. or less high, clothed with short glandular hairs; leaves awl-shaped, triangular in cross-section, pungent, glandular-ciliate, 5 mm. or less long, squarrose; those of the flowering stems similar, usually glandular-hairy on the back, erect, passing into scarious bracts above; flowers single, terminating simple stems, or in open few-flowered cymes; sepals 5, 2.5 to 3.5 mm. long, ovate to ovate-lanceolate, scarious-margined, with a thick green midrib excurrent into a point; petals 5 or 6, oblong-oblanceolate, broadly obtuse; stamens 10 to 12; styles 3 or 4.

* Proc. Amer. Acad. Sci., XII, 1877, 53, pl. II.

† Idem, XII, 1877, 52, and XXII, 1887, 270.

Type specimen in the United States National Herbarium, No. 1653, Death Valley Expedition: collected August 20, 1891, at timber-line on a divide northwest of Whitney Meadows, Sierra Nevada, Tulare County, California, by Frederick V. Coville.

The plant is of especial interest because it is evidently a local alpine species derived not from the circumpolar *Arenaria biflora* and *A. arctica*, but from some local species of a lower zone, similar to *A. fendleri*. Its sepals distinguish it at once from the circumpolar plants mentioned above, in which these organs are thin, striate, and obtuse. In habit, however, it closely resembles them, having attained the depressed, matted, shrubby form so protective to plants at high altitudes.

Brickellia desertorum sp. nov.

Shrubby, about 1 m. high; branches minutely white-tomentose, becoming glabrous in the second or third year, but still with a white epidermis, afterward gray; leaves alternate, minutely cinereous-tomentose; petioles 2 to 5 mm. long; blades deltoid ovate, truncate at the base, crenate-dentate, commonly 3 to 8 mm. long, on vigorous shoots reaching 16 mm. in length; heads in glomerules of 2 to 4 flowers, on short leafy branches from a main axis, or in the second or third year the branches elongated and divaricate and bearing a single terminal glomerule; involucre 7 to 8 mm. high, about 10- to 12-flowered; bracts 3-nerved, with traces of minute tomentum, 1 mm. or less wide, bluntly acute, the outermost oblong-lanceolate, all widely recurved after the maturing of the achenia; achenia 2 mm. long, sparingly short hispid; pappus scabrous.

This plant differs from *B. californica* in its more shrubby branches, whiter stems, much smaller canescent leaves, and heads smaller throughout. In *B. californica* the involucres are commonly 10 to 12 mm. long and the bracts obtuse, while the achenia are 3 mm. long.

Type specimen in the United States National Herbarium; collected November 7, 1889, between Banning and Seven Palms, on the Southern Pacific Railroad, California, by C. R. Orcutt.

The type specimen of *B. californica* was collected by Douglas probably near San Francisco or Monterey. That species is known in the coast region of California from Mendocino county as far south at least as San Diego. Specimens from Utah and Arizona

have been referred to *B. californica* only with doubt. The new species is known only from the Colorado and Mohave Desert regions. It shows close relationship, too, with the type form of *B. reniformis*, but differs from it, as from *B. californica*, in canescence and size of leaves, heads, and achenia.

Buddleia utahensis sp. nov.

Shrub 20 to 30 cm. high, young branches leaves and calyces densely tomentose; leaves linear to narrowly linear-oblong, irregularly crenate, with undulate revolute margins, conspicuously venose-reticulate, 1.5 to 2 cm. long, reflexed or divaricate on petioles 1 to 2 mm. long, with smaller leaves axillary-fasciculate; inflorescence made up of 2 to 4 distinct spheroidal congested clusters (about 1.5 cm. in diameter and about the same distance apart) of flowers spicately arranged at the extremities of the branches; bracts subtending the clusters similar to the leaves, the uppermost much smaller; calyx lobes 1-nerved; corolla in dried specimens brownish purple, weathering to straw color, tube tomentose without, lobes widely spreading; anthers sessile in the throat of the corolla.

This plant is closely related to *B. marrubiifolia*, but is readily distinguished by its spicate flower clusters and narrow leaves. In that species the single sperical head terminates the branches upon a well defined peduncle, while the leaves vary from ovate to obovate with cuneate base.

Type specimen in the United States National Herbarium; collected in 1877 near St. George, southern Utah, by Edward Palmer.

The plant has been collected but twice, once in the type locality and now at the foot of a limestone cliff just north of Mountain Spring, near Olcott Peak, Charleston Mountains, Nevada. The former is the most northerly locality known for any species of the genus. *B. marrubiifolia* is known in the United States only in southern Texas.

Erigeron calva sp. nov.

Apparently biennial, widely branching from the base, 1 cm. high, sparingly canescent with hirsute pubescence; radical leaves very numerous, blade oblong to obovate, 1 to 1.5 cm. long, tapering into a petiole of twice that length; upper leaves spatulate, becoming much smaller; heads singly pedunculate

on the branches, 7 to 8 mm. high, hemispherical, with very many flowers; involucral bracts narrowly linear, acuminate, hirsute; ray flowers numerous, but with rays minute, pink, and shorter than the disk; pappus of ray and disk flowers alike, consisting of several long, stout, closely barbellate bristles (4 mm. long), equalling the disk corollas, and a few intermediate much shorter ones; achenium compressed, short villous.

This species resembles in general appearance no described *Erigeron*. Its heads closely resemble those of *E. supplex*, but that species has no ray flowers whatever. Its pubescence is similar to that of *E. concinnus*. The specific name refers to the bald appearance of the heads, due to the minuteness of the rays.

Type specimen in the United States National Herbarium, No. 870, Death Valley Expedition; collected May 16, 1891, at the foot of the Inyo Mountains, about four miles north of Keeler, California, by Frederick V. Coville.

Erysimum asperum perenne Watson, var. nov.

Apparently perennial, the old stem-base horizontal or nearly so; stem erect, 25 to 50 cm. high; radical leaves oblong to oblanceolate, entire or very sparsely denticulate-dentate, tapering into a long petiole, sparsely strigose (like the stem) with the pick-shaped hairs of *E. asperum;* stem leaves narrowly oblanceolate; petals light yellow; fruit wanting.

Type specimen in the United States National Herbarium, No. 1487, Death Valley Expedition; collected August 5, 1891, between Mineral King and Farewell Gap, Sierra Nevada, Tulare County, California, by Frederick V. Coville.

Dr. Watson, in answer to my letter (forwarded to him with the specimens) saying that this plant appeared distinct from *E. asperum* and similar to *E. pumilum* of Nuttall, determined the plant questionably as a new variety of *E. asperum*, and sent the following note: "This may be distinct, but it is impossible to define a new species from this material. It has not the habit of '*E. pumilum*,' which is a very dubious species. Its perennial character, as your specimens show, is not always obvious, and our other high mountain specimens from California and elsewhere do not help to distinguish it from *E. asperum*." The plant differs conspicuously from the ordinary Californian form of *E. asperum* in its yellow instead of orange petals, perennial rootstock, smaller size, less canescent herbage, and broader root-leaves, and, furthermore,

in its geographic range at a uniformly higher altitude, above the belt of *Pinus jeffreyi*, to which, with that of *Pinus ponderosa*, the former appears to be confined.

Frasera tubulosa sp. nov.

Plant a biennial or short-lived perennial, in our specimens about 60 cm. high; stem stout, terete, glabrous, glaucous, about 6 mm. thick at the base; radical leaves in a dense rosette, linear-oblanceolate, obtuse, mucronate, reaching 1 cm. in width and 9 cm. in length, usually conduplicate and the apex recurved, thick, minutely scabro-puberulent, glaucous in appearance, its margin white, cartilaginous, entire; stem leaves similar, becoming smaller above, in whorls of 5 or 6; inflorescence a narrow spicate panicle 30 to 40 cm. long, interrupted below, its branches reaching 5 cm. in length, mostly shorter, erect; pedicels 2 to 20 mm. long, erect; sepals 4, linear-subulate, 6 to 8 mm. long, often spinulose-denticulate toward the base; petals 4, white, oblong-obovate, acuminate, 9 to 11 mm. long, slightly gibbous at the base; gland on the face of the petal none, but represented by a tube of the same texture, and half as long, as the corolla, inserted over the gibbosity at the base of the petal, split about half way to the base in a direction tangential to the axis of the flower, the posterior lobe slightly larger and both lacerate-fimbriate; stamens 4, filaments about as long as the sepals, anthers oval, 2 mm. long; ovary compressed, oblong-lanceolate, tapering into 2 subulate appressed styles, the whole equalling the stamens; placenta at the edges of the ovary, not intruded; ovules 6 to 10, oblong, very thin and flat; stigmas recurved-spreading, flat, hardly broader than the style; capsule very flat; valves obovate-oblong, with callous thickened margins and 1 median nerve continued into the stiff subulate persistent style, the whole 12 to 14 mm. long; seed single, lamelliform, oblong, minutely cellular-muriculate, about 5 to 7 mm. long.

This plant differs from all other species of the genus in the apparent absence of the petaline gland and in the presence of the tubular nectary described above. The leaves are very similar to those of *F. albomarginata*, while the form of the inflorescence resembles that of *F. nitida* and *F. albicaulis*.

Type specimen in the United States National Herbarium, No. 1598, Death Valley Expedition; collected August 17, 1891, in

dry soil under *Pinus jeffreyi* in the northeast corner of the enclosure at Soda Springs, on the north fork of Kern River, Sierra Nevada, Tulare County, California.

Gilia setosissima punctata var. nov.

Flowers and fruit larger than in the type form; corolla with tube about 10 mm. long, its lobes 7 to 10 mm. long, white, with purple dots sometimes arranged in longitudinal lines, and a pair of golden spots at about the middle; capsule 6 to 9 mm. long, often with 10 seeds in each of the 3 cells.

The plant differs from the type form in the characters above mentioned. In *G. setosissima* the corolla tube has about the same length, but the lobes are much smaller (3 to 5 mm. long) and cream-colored, with neither purple nor yellow markings, and the capsule is commonly about 5 mm. long with about 5 seeds in a cell. This variety holds the same relation to the type form that *G. matthewsii* does to *G. schottii*, except that in the case of the latter two species the differentiation appears to be complete, while in the former integrades in size and coloration occur. The flowers of *G. setosissima* and its variety are regular, erect, and with straight stamens, while those of the other two species are irregular, inserted at an angle or even horizontally, and have ascending stamens. In herbarium specimens this irregularity is often obscured, and *G. schottii* is frequently confounded with *G. setosissima*. Both *G. schottii* and *G. matthewsii* are, however, readily distinguishable from *G. setosissima* and its variety by a vegetative character which was originally pointed out* by Watson, but which was afterward lost sight of. In the former the lateral bristles of the leaf arise singly, in the latter in twos (rarely singly or in threes), from each hair tubercle. This character is constant.

These four plants are very interesting from the standpoint of their genealogical interrelation. The parent form probably was, or was very similar to, *G. setosissima*; from this *G. schottii* developed; and then, from both these, plants with larger, strikingly colored corollas differentiated, *G. setosissima punctata* and *G. matthewsii* respectively. The name adopted for the variety is one used on herbarium specimens by Dr. Gray but never published.

Type specimen in the United States National Herbarium, No. 716, Death Valley Expedition; collected April 21, 1891, in Sur-

* Bot. King Surv., 1871, 267.

prise Cañon, Panamint Mountains, California, by Frederick V. Coville.

Isomeris arborea globosa var. nov.

Stem not glaucous; petals ovate, sub-palmately veined; capsule globose, truncate or retuse, 2.5 to 3.5 cm. long; seed with a transverse groove between hilum and body; otherwise as the type form.

Our plant differs conspicuously from the type form in the shape of its capsules, a character at once noticeable in the living plant. The stems of the new year's growth in the type form are glaucous; the petals narrowly oblong and pinnately veined; the capsules oblong, attenuate into the stipe, abruptly tapering at the apex; and the seeds without a groove between the hilum and the body. The same plant as ours, but without mature fruit, was collected by Xantus de Vesey near Fort Tejon in 1857–58.

Type specimen in the United States National Herbarium, No. 1107, Death Valley Expedition; collected June 24, 1891, on Caliente Creek, a few miles above Caliente, Kern County, California, by Frederick V. Coville.

The characteristic distribution of this variety was not ascertained. It might be expected to be a form modified by proximity to the Mohave Desert, but the type form enters the western portion of this desert in at least one place, Tehachapi Pass; and flowering specimens, presumably of the type form, were seen in April about forty miles from Mohave on the road from that place to Searles' borax establishment.

Lepidospartum striatum sp. nov.

Shrub 1 to 1.6 m. high, with a stout erect trunk; branches numerous, erect, striate-angled by 3 ribs decurrent from each leaf-base, closely white-tomentose, the ribs resiniferous and glabrous; leaves alternate, filiform-linear, thicker above, acute, slightly spreading, 20 to 25 mm. long, or the upper only 10 mm.; heads 2 to 5 at the apex of the branch, singly sessile, or very short-peduncled, in the axils of leaf-like bracts, 12 to 16 mm. long; involucre oblong to narrowly oblong, 7 to 10 mm. high; bracts about 9, broadly ovate to narrowly oblong, obtuse, stiff, coriaceous, with narrow membranaceous margin, lanate on the back, imbricated, the outer successively shorter; flowers 5; corolla

lobes linear-lanceolate, acute, longer than the throat, with marginal nerves and an oblong or linear resin duct at the apex; anthers acutely sagittate at the base; anther-tips obtuse; styles 2 to 2.5 mm. long, linear, bluntly acute but short-hairy so as to appear obtuse; achenium densely villous with spreading long white hairs; pappus copious, white, of conspicuously scabrous soft bristles.

This plant has the general appearance of a *Tetradymia*, but the involucre and style-tips of *Lepidospartum*. The branches resemble those of *T. glabrata*, except that the decurrent leaf-base is made up of three slender ribs instead of one broad line. The leaves too are very similar to the primary ones of that species. The involucral bracts are thoroughly imbricated, and in this respect are quite different from those of any *Tetradymia;* yet their texture and pubescence are the same. The pappus and achenia closely resemble those of *T. glabrata* and *T. canescens inermis*. The median nerve of the corolla lobes in *Tetradymia* and in *Lepidospartum squamatum*, which are really resin ducts, are here reduced to large linear or oblong apical resin glands not produced to the base of the lobe. The anther tip is really acute but from the hairs about it appears obtuse, and somewhat resembles that of *Tetradymia*. The plant forcibly suggests the reuniting of *Lepidospartum* with *Tetradymia*, as a subgenus, a position in which Dr. Gray* once placed it, but the involucres of the two genera are of quite different types.

Type specimen in the United States National Herbarium, No. 558, Shockley, 1888; collected in August, 1888, in Soda Springs Cañon, Esmeralda County, Nevada, by W. H. Shockley.

Mentzelia reflexa sp. nov.

Plant annual, 20 cm. or less high; stem stout, diffusely branching from the base, brownish white and striate when dry, hirsute, as well as the leaves and calyx lobes, with retrosely barbed, as well as with upwardly denticulate, hairs; leaves from linear-oblanceolate below to ovate or even hastate above, short-petioled or sessile, all irregularly sinuate-dentate or the lowest almost pinnatifid; flowers single on short usually 1- or 2-leaved axes in the forks of the stem; ovary broadly oblong, 4 to 5 mm. long,

* Proc. Amer. Acad. Sci., IX, 1874, 207.

hirsute; calyx lobes triangular-subulate, about 1.5 mm. broad at base by 5 to 6 mm. long; petals oblong-oblanceolate, tapering to a bluntly acute apex, equalling the calyx lobes; staminodia none; stamens 9 to 13, shorter than the calyx; filaments expanded at base only, or almost to the apex, to a width of about .5 mm.; anthers small, about as broad as long; placentæ 3, broad, fleshy; ovules about one-half imbedded in the placentæ; style cleft for about one-third its length, equalling the stamens; capsule oblong, 8 to 10 mm. long, its pedicel reflexed at the apex; seeds about 10 or 12 in each capsule, gray, somewhat compressed, angularly obovate or pyriform, slightly constricted below the middle, and with a deep transverse groove on either face along this line, muriculate throughout.

This plant appears not to be closely related to any known species of *Mentzelia*. It resembles in its petals, stamens, and seeds *M. torreyi*, and in the last of these organs *M. tricuspis* and its allies. Its characteristic external features are its diffusely branched but stiff habit, its flowers scattered in the forks of the stem, and its reflexed fruiting pedicels. Its seeds resemble those of *M. tricuspis*.

Type specimen in the United States National Herbarium, No. 709, Death Valley Expedition; collected April 21, 1891, in Surprise Cañon, Panamint Mountains, California, by Frederick V. Coville and Frederick Funston.

Phacelia perityloides sp. nov.

Suffrutescent perennial 10 to 20 cm. high, diffusely branched, densely leafy; stem, as well as branches, leaves, and calyx, viscid with glandular hairs, or at the base densely villous-tomentose; leaves alternate; petiole 7 to 15 mm. long; blade orbicular with truncate to cordate base, crenate-dentate or even lobed, 7 to 12 mm. in diameter, the hairs shorter than on the stem and petiole; flowers in loose racemes terminating the branches; pedicels 3 to 5 mm. long; calyx about 4 mm. long, the lobes oblong-spatulate, obtuse; corolla cream-white, sparingly glandular-hairy, twice as long as the calyx, its narrowly campanulate tube longer than the calyx and its short orbicular lobes abruptly spreading; appendages 10 semilanceolate vertical lamellæ free from the filaments; the 3 veins of each corolla lobe continuing distinct to the base of the tube; stamens included

in the throat of the corolla; anthers oblong; ovary and included style sparingly short hairy; style tips very short, divergent; capsule narrowly ovate, bluntly acute, 3 to 4 mm. long; seeds apparently very numerous, oblong, angulate by compression, scrobiculate, 5 mm. long.

The plant closely resembles a small congested specimen of *Peritylc emoryi*. The form of the leaves is very similar to that in *P. rotundifolia*, but the plant, while belonging to the subgenus *Eutoca*, differs from all its species in being suffrutescently perennial. The cream-white corollas form another conspicuous character.

Type specimen in the United States National Herbarium, No. 524, Death Valley Expedition; collected March 31, 1891, in Johnson Cañon, Panamint Mountains, California, by Frederick V. Coville.

Potentilla eremica sp. nov.

Plant of the sub-genus *Ivesia*, perennial, in large tufts from a branched caudex, villous-canescent throughout; stems few, erect or procumbent, 10 to 20 cm. high, sparingly short-leafed; radical leaves many, the largest 13 cm. long, terete; leaflets sometimes 60 pairs, entire, broadly ovate, acute or obtuse, 2 to 2.5 mm. wide, closely imbricated in 2 rows along the rachis; stem leaves similar, shorter, borne at intervals of about 1 to 2 cm., the uppermost not exceeding 1 cm. in length; cyme narrow, about 5 cm. long; bracts simple or few-cleft, about 3 mm. long; pedicels 5 to 7 mm. long, erect; calyx 3 to 4 mm. long, lobes lanceolate-acuminate; calyx bracts ovate; stamens 20; pistils apparently 2 or 3; hairs of the receptacle dense, conspicuous, 1 to 1.2 mm. long.

This plant was collected in winter, so that only the remains of the inflorescence of the preceding year were found. The leaves at first sight closely resemble those of *P. santolinoides*. The plant was found in but one place, about two miles east of Watkins' ranch (and about one-half mile south of the "devil's hole"), in an alkaline limestone marsh on a sloping gravelly mesa, growing with *Spartina gracilis*, *Anemopsis californica*, and *Schœnus nigricans*.

Type specimen in the United States National Herbarium, No. 366, Death Valley Expedition; collected March 2, 1891, near Watkins' ranch, Ash Meadows, Nye County, Nevada.

Potentilla purpurascens pinetorum var. nov.

Plant cæspitose from a many-branched caudex; stems about 3 cm. high; inflorescence loosely cymose; radical leaves very numerous, 7 to 14 cm. long; lower leaflets about 7 mm. long, 2-divided, the divisions often 2-lobed; upper leaflets merely 2-lobed; divisions in both oblong-oblanceolate, glabrous or very scantily villous; otherwise as the type form.

In aspect our plant is quite different from Rothrock's specimens of the type form,* they being but 5 to 16 cm. high, with shorter leaves, and shorter, broader, more congested, villous-hirsute leaflets. The characters of the flowers are identical. The following references to *Potentilla purpurascens* may be helpful: Wats. Proc. Amer. Acad. XI 148 (1876) under *Horkelia;* Greene, Pittonia I 105 (1887).

Type specimen in the United States National Herbarium, No. 1579, Death Valley Expedition; collected August 10, 1891, at Trout Meadow, Sierra Nevada, Tulare County, California, by Frederick V. Coville.

Our plant was abundant throughout the valley of the north fork of Kern River, in forests of *Pinus jeffreyi*, along the rather dry margins of meadows. Rothrock's came from a higher altitude, 9,000 feet, "on the head-waters of Kern River," and is undoubtedly a derivative form modified by changed conditions.

Sarcobatus baileyi sp. nov.

Shrub .5 to 1 m. high; bark dark gray after the first year; branches divaricate, closely interlocking, the ultimate branchlets always spinescent; leaves 8 to 14 mm. long or shorter, pubescent, especially near the apex, with short, flattened, branched, reflexed hairs, the later leaves often glabrate in age; male spike not seen; fertile spikes infra-axillary on old wood, consisting of 2 female flowers at the base (one often wanting), each in the axil of a leaf, and a terminal spiciform portion of male flowers, the whole axis 1 to 1.5 cm. long; fruit very large; body 8 to 9 mm. long, about 5 mm. broad at its widest point; wing oblong-orbicular, erose, 10 to 15 mm. by 8 to 10 mm. in diameter; seed not developed.

The plant differs from *S. vermiculatus* in its smaller size, always spinescent branchlets, intricate and compact growth, smaller and

* Bot. Wheeler Surv., 1876, pl. III.

usually pubescent leaves, larger fruit, and different inflorescence. *S. vermiculatus* usually grows, in Nevada, 1.2 to 1.8 m. high, with branches less intricate and often not spine-tipped, and leaves when well developed 12 to 20 or even 30 mm. long and almost invariably glabrous. Its fertile flowers are described by Bentham and Hooker* as axillary and solitary, but the axis on which they are borne is really continued into a rudimentary male spikelet similar to that of *S. baileyi*, but each floral axis, instead of bearing 1 or 2 female flowers as in that species, commonly has from 4 to 8. In *S. vermiculatus* the body of the fruit is 4 to 5 mm. long, 2.5 to 3.5 mm. broad, and the wing 7 to 13 mm. by 5 to 8 mm. in diameter.

Type specimen in the United States National Herbarium, No. 1994, Death Valley Expedition; collected June 2, 1891, in a valley near Thorpe's quartz-mill, Nye County, Nevada, by Vernon Bailey.

The plant was first seen by Mr. Bailey at Cloverdale, Esmeralda County, Nevada, in 1890, and recognized by him as different from *S. vermiculatus*. In company with Dr. Merriam he afterward found it in a valley in Nye County, Nevada, southeast by east from Gold Mountain, near Thorpe's quartz-mill, and later in Fish Lake Valley westward from the other localities, on the California state line. There is in the National Herbarium a specimen of the same plant collected by J. G. Lemmon in 1875, probably in western Nevada. The species is therefore confined, so far as known, to the counties of Esmeralda and Nye, in Nevada, and Mono and Inyo, in California. I take pleasure in associating Mr. Bailey's name with this shrub, both as a mark of his earnest and invaluable labors in the field of natural history and as a reminder of a warm friendship established among the vicissitudes of a desert exploration.

Saxifraga integrifolia sierræ var. nov.

Blades of larger leaves 8 to 12 cm. long, oblong-lanceolate to elliptical-lanceolate, acute, conspicuously serrate-denticulate, from glabrous to sparingly clammy-hairy above and beneath, thinner and more distinctly veined than in the type; petiole and margin of the leaf toward the base ciliate with clammy hairs; otherwise as the type form.

* Gen. Pl. III, 1880, 76.

Type specimen in the United States National Herbarium, No. 1705, Death Valley Expedition; collected August 25, 1891, about eight miles northwest of Whitney Meadows, on the headwaters of Kern River, Sierra Nevada, Tulare County, California, by Frederick V. Coville.

The species was described* from specimens collected by Scouler "near the mouth of the Columbia, northwest coast of America," and is excellently figured.† Specimens collected in later years in the same region agree with Hooker's description and figure in being viscid-pubescent throughout, and in having the leaves oblong, entire, obtuse, and scarcely exceeding 3.5 cm. in length. None of the specimens from the Sierra Nevada resemble the type form, but a good series of intergrades exist between the two regions and in the Rocky Mountains where the variety occurs also.‡ The Sierran plant appears never to have been described except in the Botany of California, where the description of the type form is varied to include it. In Dr. Gray's conspectus of the species of Saxifraga§ it is not distinguished from Hooker's plant.

Stylocline arizonica sp. nov.

Plant of the subgenus *Eustylocline*, 5 cm. or less high; habit that of *S. micropoides*; leaves obtuse or abruptly acute; heads 4.5 to 6 mm. high; bracts of the receptacle broadly winged around the conduplicate portion; achenium lunate.

The species differs from *S. micropoides* in its prevailingly obtuse leaves, its winged bracts, and its lunate achenia; that species having narrowly acute leaves, bracts not produced into wings at the margin, and straight achenia. From *S. gnaphaloides* it differs in its smaller size, larger heads, and linear-oblong leaves. *S. gnaphaloides* attains a height of 8 to 10 cm. and is very diffusely branched, while its heads are seldom more than 3 mm. high and its leaves are oblanceolate with a tapering base.

Type specimen in the United States National Herbarium; collected May 1, 1867, on the Verde Mesa, Arizona, by Dr. Charles Smart.

* Hook. Fl. Bor. Amer., I, 1833, 249.

† Loc. cit., t. 86.

‡ Wheeler Survey, No. 796.

§ Proc. Amer. Acad. Sci., XX, 1884, 8–12.

The species undoubtedly is confined to the Lower Sonoran zone of the desert region. *S. guaphaloides* belongs to the intramontane region of California.*

* The word "intramontane" is applied here to that portion of California west of a line of mountains made up of the Sierra Nevada, San Bernardino, and San Jacinto ranges, together with their connecting ridges. That area is thus distingnished from the ultramontane or desert and Great Basin portions of the state. The two regions are marked by distinct characteristic floras. North of the Sierra Nevada and south of the San Jacinto Mountains the precise location of the dividing line has not been clearly determined.

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PROCEEDINGS

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SOME INTERRELATIONS OF PLANTS AND INSECTS.*

BY C. V. RILEY, PH. D.

It is my purpose to-night to present some phases of the curious interrelations between plants and insects. In doing this I shall not have time to deal with the remarkable series of results that have followed the more careful and accurate investigation of the so-called insectivorous or carnivorous plants, and which have shown that these plants are not only possessed of the power of movement depending upon nerve stimuli, that may be likened in almost every respect to the automatic movements of animals, but that they actually possess digestive powers and properties which, chemically and functionally, are the same as those by which animals digest their food. It is my desire rather to call your attention to certain phases of plant fertilization by insects.

*This communication was presented for the most part extemporaneously, with the aid of stereopticon views. In preparing it, by request, for the printer, I have assumed that the facts already published in reference to Yucca pollination are familiar to the members of the Society, and have presented in the briefest manner such only as throw light on the philosophical portion of the article. The descriptive portion is condensed from a more extended paper recently prepared for the Annual Report of the Missouri Botanical Garden, but not yet published, and the illustrations are for the most part borrowed in advance from that paper. Figures 8, 10, 11, 12, and 13, however, are from my previous publications; Figure 6 was prepared specially from the stereopticon slide; and Figures 2, 3, and 4 are from the Department of Agriculture and used by permission of Assistant Secretary Willits.

I need not tell the members of this Society that the old idea that flowers were endowed with beauty and fragrance for our particular pleasure has been effectually set aside, and that these attributes have come to be looked upon in their true light, as essential to the plant's existence and perpetuation; that, in other words, color, form, odor, secretions, and the general structure of flowers, all have reference to insects. Nor need I dilate on the need of cross-fertilization in plants generally, or the modification which insect pollinizers have undergone as a consequence of this need. Some of the more interesting facts are particularly well exemplified in our orchids, to the philosophic study of which Darwin's important work "On the Fertilization of Orchids" gave a distinct impulse. But here we have adaptation of the plant only, and, with scarcely an exception, most flowers, including those of our orchids, may be fertilized by different insects. There are, in fact, few which are dependent on a single species for pollination, and, so far as I know, our Yuccas furnish the only instance of this kind. It is to the fertilization of these plants that I would first draw your attention.

The Yuccas are a characteristic American group of liliaceous plants, finding their home more particularly in the southern United States and Mexico. There are many species which have been divided even into sub-genera by Dr. Engelmann, as Sarcoyucca, Clistoyucca, Chenoyucca, and Hesperoyucca; but for our present purpose they may all be included under the one genus Yucca, as they all possess certain characteristics in common, viz, a thick, sub-mucilaginous root, which is in reality a subterranean stem; lance-shaped, evergreen leaves, narrow or broad, rigid or flaccid, and with the edges either filamentose, smooth, or more or less distinctly serrate. The leaves produce a coarse fiber, valuable for certain kinds of fabrics, while the trunks of the tree Yuccas have been used to make the toughest kind of paper. The fruit of some species, as of *aloifolia* and *baccata*, is fleshy and edible. It is, however, the flowers to which I would draw more especial attention. They are produced in large panicles, and are characterized as a rule by the anthers not reaching anywhere near the stigma; so that fertilization unaided can take place only by the merest accident. The Yuccas show great variation in detail, both in leaf, general habitus, flower-stalk, flower, and fruit, from the common sessile *Yucca filamentosa* of our gardens to the arboreal forms, like

brevifolia of the Mohave Desert and *filifera* of Mexico. My remarks will be based chiefly on *Yucca filamentosa*, which is indigenous to the Southeastern States and is cultivated beyond its natural range, under a number of horticultural variety names, in our gardens.

An examination of the flower will show at once the peculiarities which I have alluded to as characteristic of the genus. The stamens or filaments are bent away from the stigma and do not reach more than two-thirds the length of the pistil, the stigmatic opening being at the tip of the prolonged style and nowhere within reach of the stamens, while the pollen either remains attached to the open and withered anthers or falls in different sized lumps on the underside of the perianth. It cannot be introduced into the stigmatic tube without artificial aid, and the plant depends absolutely on the little white moth belonging to the Tineina and known as *Pronuba yuccasella* Riley.

Structural Characteristics of Pronuba.

Upon a superficial view, this little moth shows nothing very peculiar. The general coloration is white, the primaries being purely white on the upper surface; so that when at rest in the half open flowers of the Yucca it is not easily detected. The under surfaces, however, are dusky and offset in flight the whiteness of the rest of the body, so as to render the species somewhat difficult of detection while flitting from plant to plant. The male shows no very marked peculiarities to distinguish him from the other members of the family, the most noticeable being, perhaps, the prominence of the exposed parts of the genitalia. The female, however, shows some remarkable structural peculiarities, which admirably adapt her for the functions she has to perform, for she must fertilize the plant, since her larvæ feed upon its seeds.

Now, if I should ask any well-informed entomologist what are the characteristics of the Lepidopterous mouth, in the imago state, he would unhesitatingly answer: The lack of all prehensile organs and a coiled tongue capable of sucking liquids. If again I should ask what distinguishes the Lepidoptera from, say, the Hymenoptera, in the methods of oviposition, he would answer that the Lepidoptera lay eggs possessing, it is true, an infinite diversity of form, but usually attached externally to some part of the food-plant of the species, while the Hymenop-

tera as a rule secrete theirs, and are furnished with either a puncturing, boring, or sawing instrument for that purpose. The generalization would be entirely justified, though there are many curious exceptions to it, especially in the very group Tineina, to which our Yucca moth belongs. It is, however, necessary to

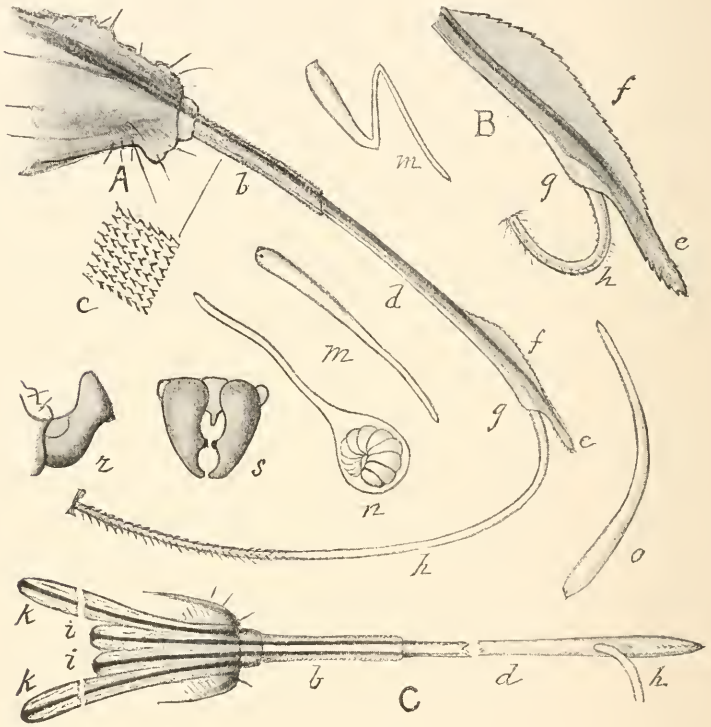

FIG. 1.—A, tip of anal joint and vaginal projection of ♀ *Pronuba yucca-ella* from side, showing ovipositor with parts extended: *b*, basal joint; *c*, its file-like surface; *d*, terminal joint, with its dorsal serrate wing (*f*), its dentate tip (*e*), its ventral membranous outlet (*g*), and the extended oviduct (*h*); B, the same parts further enlarged; C, ventral view of tip of abdomen, showing the two pair of rods *i*, *i* and *k*, *k*, with their muscular attachments, the parts of the ovipositor similarly lettered as in A; *m*, *m*, eggs taken from Yucca pistil; *n*, egg, showing development of embryon; *o*, mature egg from ovary of ♀; *r*, *s*, genital claspers of ♂, lateral and dorsal view—all enlarged.

state these general truths in order to convey a just idea of the exceptional nature of the two organs to which I wish more particularly to draw your attention. The first is a pair of maxillary tentacles which are prehensile and spinous on their under surface. They are peculiar to the genus Pronuba and exist in no other genus

of the many thousands of butterflies and moths.* The other organ is the ovipositor, which, instead of being a simple opening, as typically found in Lepidoptera, is here modified into a complex combination of lance and saw. Ordinarily it is withdrawn and hidden, but when in action is projected far beyond the tip of the abdomen and is then seen to consist of two principal parts the basal part being imbricato-granulate—*i. e.*, having a delicate file-like structure, the terminal part being smooth, but having near the end a dorsal serrate chitinous wing and a still more strongly toothed corneous tip. The internal structure is seen to consist of two stout rods, extending along the thin walls to the very tip, and of a ventral canal or passage-way for the delicate oviduct, which is silk-like and elastic and may be extruded for a great length from an outlet near the end of the ovipositor. This oviduct is smooth basally, but armed along its terminal third with retrorse hairs, increasing somewhat in number and strength toward the tip, around which they are almost spinous. At first sight these would seem to be out of place and to impede rather than aid the insertion of such a delicate filament; but, as we shall presently see, the act of oviposition is a most intricate and difficult one and these hairs are doubtless sensitive and tactile and serve the double purpose of enabling the moth to feel her way in the ovarian cell and of temporarily anchoring in the soft wall thereof while the egg is being passed to its destination. It will be seen that this ovipositor is admirably adapted for cleaving through the young fruit and then running the egg into the ovarian cavity, as will be presently described. The manner in which this ovipositor is worked by the four rods attached to strong muscles is indicated at Fig. 1, C, the two inner rods forming, as already indicated, the rigid portion of the ovipositor proper and the imbricate basal portion of the covering facilitating the invagination of the basal part when the ovipositor is withdrawn. The two outer rods are attached to strong muscular tissue in the walls of the vagina, and when the ovipositor is extended to its utmost limit this vaginal portion is partially extruded so as to appear like a basal subjoint. More detailed characterization of these parts is unnecessary in this connection.

* There are over 12,000 described species of Lepidoptera from Europe and America, and those from other parts of the world will double this number. Nearly as many more remain, perhaps, to be described.

The Acts of Pollination and Oviposition.

Having thus drawn attention to the most characteristic structures of Pronuba, we shall better understand the following account of the acts of pollination and oviposition which I quote from an article recently prepared for the Annual Report of the Missouri Botanic Garden:

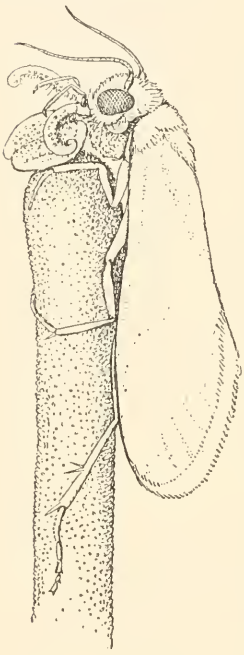

Fig. 2. — Female *Pronuba yuccasella* gathering pollen, × 5.

"Though all the acts of the female are nocturnal, it is not at all difficult to follow them with a lantern, for, albeit ordinarily shy, she may be closely approached when about to oviposit. Her activity begins soon after dark, but consists, at first, in assiduously collecting a load of pollen. She may be seen running up to the top of one of the stamens and bending her head down over the anther, stretching the maxillary tentacles, so wonderfully modified for the purpose, to their fullest extent, the tongue uncoiled and reaching to the opposite side of the stamen. In this manner she is able to obtain a firm hold of the stamen, while the head is kept close to the anther and moved peculiarly back and forth, something as in the motion of the head of a caterpillar when feeding. The maxillary palpi are used in this act very much as the ordinary mandibles are used in other insects, removing or scraping the pollen from the anthers toward the tentacles. After thus gathering the pollen she raises her head and commences to shape it into a little mass or pellet by using her front legs very much as a cat does when cleansing her mouth, sometimes using only one leg, at another time both, smoothing and pressing the gathered pollen, the tentacles meanwhile stretching and curving. After collecting all the pollen from one anther she proceeds to another and repeats the operation, then to a third and fourth, after which, with her relatively large load—often thrice as large as the head—held firmly against the neck and front trochanters, she usually runs about or flies to another plant; for I have often noticed that oviposition, as a

rule, is accomplished in some other flower than that from which the pollen was gathered, and that cross-fertilization is thus secured.

"Once fully equipped with this important commodity, she may be seen either crawling over or resting within the flower, generally with the head toward the base. From time to time she makes a sudden dart and deftly runs around the stamens, and anon takes a position with the body between and the legs straddling two of them, her head being usually turned toward the stigma. As the terminal portion of the stamens is always more or less recurved, she generally has to retreat between two of them until the tip of her abdomen can reach the pistil. As

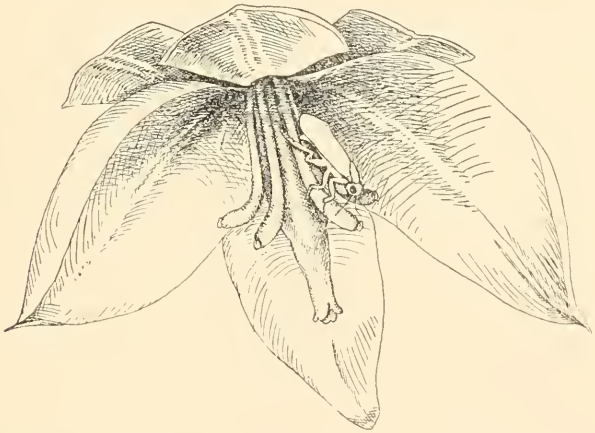

Fig. 3.—Flower of *Yucca filamentosa* with near petals removed, showing Pronuba in act of ovipositing.

soon as a favorable point is reached, generally just below the middle, she rests motionless for a short time, when the abdomen is slightly raised and the lance-like ovipositor is thrust into the soft tissue, held there the best part of a minute, while the egg is conducted to its destination, and then withdrawn by a series of up-and-down motions.

"In non-technical language, the pistil or the young fruit, below the stigmatic tube, shows externally at this time six quite distinct longitudinal divisions, each having a median ridge, there being six corresponding depressions or concavities in which the six stamens fit, especially at the base. Technically, the pistil is a three-celled ovary, the styles bifid at tip and united so as to

form the stigmatic tube. A transverse section anywhere about the middle will show that each of the six longitudinal sections contains a row of ovules within an ovarian cell. More strictly, the ovules are in pairs, as there are but three primary sections or carpels, divided by three primary divisions or dissepiments. Figure 4 shows a transverse section of one of these primary divisions or carpels which well indicates the position of the ovules (*a*), the funiculus (*b*), the placenta (*c*), and the ovarian cell (*d*). As the fruit enlarges, the three secondary dissepiments narrow and coalesce, while the other three widen, so that the pod becomes practically three-lobed and the seeds are more distinctly

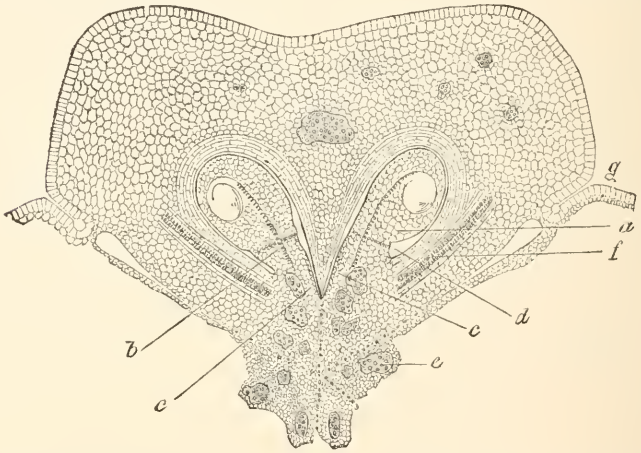

FIG. 4.—Transverse section of one of the carpels of Yucca pistil: *a*, ovule; *b*, funiculus; *c*, placenta; *d*, ovarian cell; *e*, fibro-vascular bundles; *f*, fibro-vascular tissue; *g*, primary dissepiment × 9.

in pairs, the inner side straight and the external quite convex. In oviposition the young fruit is pierced just within the ridge in the depression occupied by the stamens, and almost always on the side of one of the primary or deeper divisions, where the walls are thinnest, so that the ovipositor enters the ovarian cell at the external or rounded side of an ovule and does not ordinarily touch the ovule itself. Rarely, however, the ovipositor penetrates the ridge and passes between two of the ovules, or sometimes even penetrates one, this last case being, however, quite exceptional.

"The egg is an extremely delicate thread-like structure, averaging 1.5 mm. in length and less than 0.1 mm. (Fig. 1, *m*, *n*, *o*)

in diameter, tapering at the base and enlarging slightly toward the capitate end, which has also a slightly indurated point. It is impossible to follow it with the unaided eye or in fact with an ordinary lens, even if the pistil be at once plucked and dissected; but by means of careful microscopic sections we may trace its course. From the position assumed by the moth, the ovipositor punctures the pistil somewhat obliquely, but as the egg is much longer than the diameter of the ovarian cell, the delicate oviduct of the moth bends and then runs vertically along the inner part of the cell next the placenta, and leaves the egg extending in this longitudinal direction along some seven or eight ovules, as shown in the illustrations (Fig. 5, *c*, *c*). The apical end of the

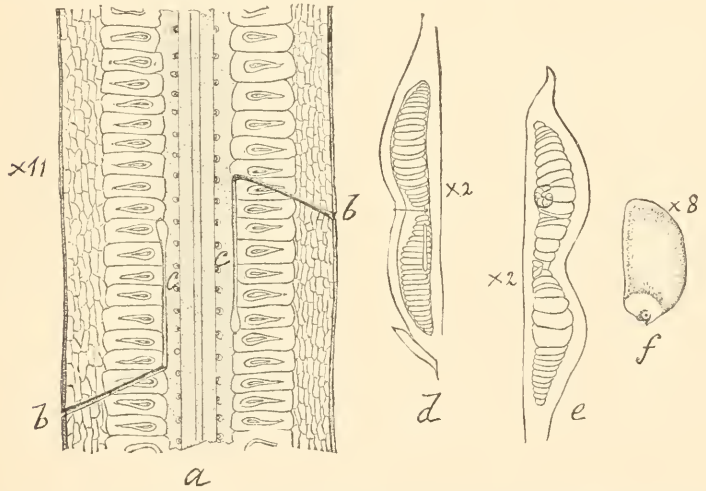

Fig. 5.—*a*, longitudinal section of pistil of *Yucca filamentosa*, showing (*b*, *b*) punctures of Pronuba, and (*c*, *c*) the normal position of her eggs in the ovarian cell; *d*, section of a punctured carpel 7 days after oviposition, showing the egg yet unhatched and the manner in which the ovules in the neighborhood of puncture have been arrested in development so as to cause the constriction; *e*, section of an older carpel, showing the larva above the original puncture; *f*, a seed 13 days from oviposition, showing young larva at funicular base—enlargements indicated.

egg soon enlarges (Fig. 1, *a*), and the embryo may be seen developing in it very much as in the case of the similarly elongate eggs of gall-flies (Cynipidæ), though the pedicel does not shorten, as observed in these last. Segmentation is noticeable on the second day, and the Yucca ovule at once begins to swell and enlarge, the irritation (doubtless mechanical) influencing the plant tissue much as in the case of the punctures of the gall-flies

just mentioned. Sometimes two or more adjacent ovules are thus affected."

It may be well right here to look a little more closely into the minuter characteristics of the Yucca flower at this stage of its development that we may understand more fully the action and influence of the moth. In my first article, published some twenty years ago, announcing the discovery of Pronuba and its action on Yucca pollination, I was strongly inclined to the idea that the act of pollination had some compensating inducement to the moth, aside from the impelling instinct of perpetuation of the species. At that time it was supposed that the stigmatic liquor was nectarian, and the conclusion was justifiable that the moth, attracted to it for feeding purposes, would incidentally induce pollination. On this view of the matter it did not require a great stretch of the imagination to conceive that the pollen might also incidentally accumulate in the spines, and that the vigorous action of the head that had been noticed might even be considered as an effort to get rid of the encumbrance while feeding. In those days I was more imbued with the common notion that lower creatures are impelled for the most part unconsciously to their acts. Twenty years of study and experience have only served to prove the acts of Pronuba the more unselfish and without food inducement. A longitudinal section of the upper portion of the pistil will show the style with the stigmatic tube, which at this time communicates with the ovarian cells. Now, Trelease has shown that the stigmatic liquor is not nectarian, but that the slight amount of nectar associated with the flower is secreted in pockets formed by the partitions that separate the three cells of the pistil, and which open externally near the style by a contracted pore from which the nectar is poured through a capillary tube to the base of the pistil. The accompanying illustration (Fig. 6) renders this more intelligible, *a* being a longitudinal section through the center of a pistil, showing the septal gland (*g*), the duct (*d*), and the outlet at base; *b*, a cross-section of the pistil about the middle, also showing the duct (*d*) and gland (*g*); *c*, a more enlarged cross-section of the nectar apparatus; *c* showing more fully the structure of the septal gland, while *b* is a longitudinal section of the top of the pistil, through the lobes, showing how the stigmatic tube (*s*) connects with the ovarian cell (*o c*), *o* being the ovary, *f* the funiculus, *p* the placenta, and *f c* fibro-vascular tissue.

These interesting facts, which I have fully verified, show that nectar-feeding insects seek it not about the stigma, but at the base of the stamens or of the petals, whether within or without. In short, the nectar in these Yucca flowers has no value in pollination, and Pronuba, in collecting the pollen and transferring it to the stigma, finds no food compensation, a conclusion which is confirmed by a study of the minute structure and internal

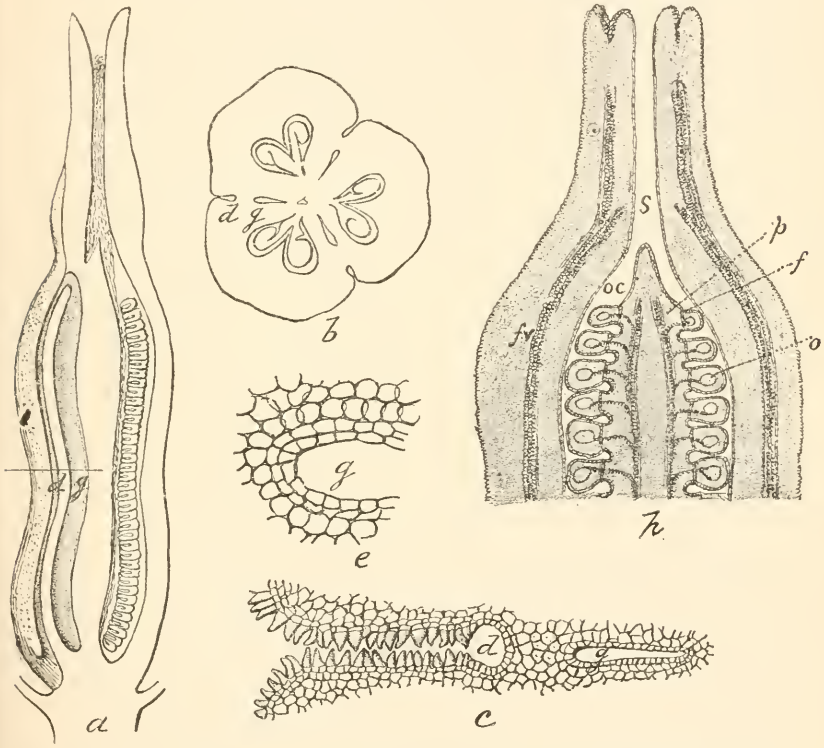

Fig. 6.—Nectar apparatus of Yucca: *a*, longitudinal section of pistil, with duct (*d*) and gland (*g*); *b*, cross-section about middle, showing same parts; *c*, still more enlarged cross-section of nectar apparatus; *e*, structure of septal gland—after Trelease; *h*, longitudinal section of top of pistil, showing stigmatic tube (*s*) ovarian cell (*oc*), ovule (*o*), funiculus (*f*), placenta (*p*), and fibro-vascular tissue (*fv*).

anatomy of the moth, which indicate that the tongue proper, though strongly developed, has to a great extent, if not entirely, lost its function as a sucking organ, and that the alimentary canal is practically functionless, being aborted before reaching the anus. This defunctionization, if I may use the term, of im-

portant structures has not proceeded so far in *Pronuba yuccasella* as in *P. maculata*, which pollinizes *Yucca whipplei*. Those not familiar with the structure of Lepidoptera will hardly appreciate the modifications to which I shall allude, however, without the preliminary statement that the tongue in Lepidoptera consists of two distinct parts (maxillæ) which are more or less concave on their inner side and united at the borders of the concave portion by certain locking arrangements to form between them the sucking tube. Now, while in most cases the two parts may be relaxed and separated by force, in nature they are never so separated, while the tip of the tongue is more or less acuminate and the two parts here very firmly united.

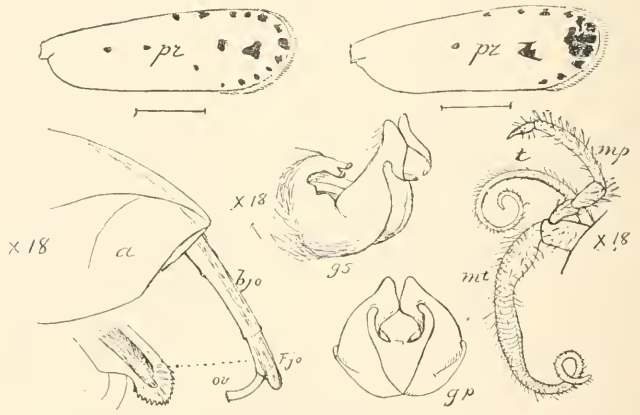

Fig. 7.—Pronuba maculata: *a*, tip of female abdomen; *b j o*, basal joint of ovipositor; *t j o*, terminal joint of ovipositor; *ov*, oviduct; *m p*, max. palpus; *m t*, maxillary tentacle; *t*, tongue; *gs*, claspers of male from side; *gp*, claspers of male from behind—enlargement indicated; *pr*, front wings, showing arrangement of spots in two of the more common forms, hair-lines showing natural size.

In *Pronuba yuccasella* I had often noticed that the two parts became separated and in fact were almost always separated toward the tip, thus suggesting a loss of function as a sucking organ, but otherwise the tongue is strongly developed, and, with the exception of the weakness of the locking arrangement, not particularly abnormal. In *Pronuba maculata*, however (Fig. 7), the two parts of the tongue are but very feebly united, and often more or less disconnected, and are actually thickly covered with minute hairs and more sparsely with longer spinous hairs, intermixed; they are also swollen and enlarged toward the base. The import of this fact can best be conveyed to you by the statement

that in all other Lepidoptera that I know of the tongue is a smooth organ and in no way armed, except near the tip. In short, the tongue in *Pronuba maculata* has become an accessory tentacle, serving and helping in pollination, but probably incapable of use for feeding purposes. These structural peculiarities justify the conclusion, which observation confirms, that Pronuba does not feed in the imago state. In other words, she has no incentive to go to the stigma with her load of pollen other than that of pollinizing, and the slight amount of nectar which the plant secretes is well calculated to lead other insects which seek it away from the stigma and thus not to interfere with Pronuba's mission.

Development and Transformations of Pronuba.

On this subject I need only remark that the action of oviposition causes a disorganization of the plant tissue in the immediate neighborhood of the apical portion of the egg and the swelling of the adjacent ovules; that the embryo develops in the capitate end of the egg, and while the larva is white at first, or of the exact color of the young ovule, it becomes slightly greenish or roseate when full grown, which is in about a month, or coincident with the ripening of the seed. It perforates the capsule and drops to the ground, having six thoracic legs, which doubtless aid it at this period of its life. It remains through the fall, winter, and early spring months in a tough cocoon, transforms to the chrysalis state about a week before the Yuccas bloom again, and finally issues as a moth to continue the annual cycle of its career. The chrysalis (Fig. 8) has a capitate spine and a series of dorsal spines, some of which are spatulate and admirably fitted for helping it to work through the ground.

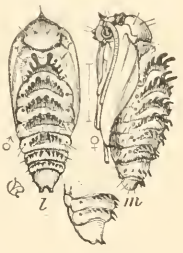

Fig. 8. — Pronuba yuccasella: *l*, male; *m*, female chrysalis.

"The effect of the puncture of the female moth on the fruit is at once noticeable by a darker green discoloration externally. In time this becomes a depression, causing a constriction of the pod, and the irregularities of the pod (Fig. 9, *b*, *c*), which have been supposed to be characteristic of the genus Yucca, are really due to these punctures, which ordinarily occur just below the middle." The absolute need of Pronuba in the pollination of our deniscent Yuccas I have proved over and over again, in many

ways. The plant never produces seed where Pronuba does not exist; it never produces seed when she is excluded artificially, and experiments which I have made with artificial or brush pollination all show that it is much more difficult to ensure complete fructification than would at first appear, and that the act of pollination is rarely performed with a brush or by using the flower's own filaments, as successfully as it is done by Pronuba. It is *Pronuba yuccasella* which pollinizes all our Yuccas east of the Rocky Mountains, so far as known, and the species is remarkably uniform in character, its appearance in time being coëtaneous with the flowering of *Yucca filamentosa*. On the western plains its appearance has become adapted to the flower-

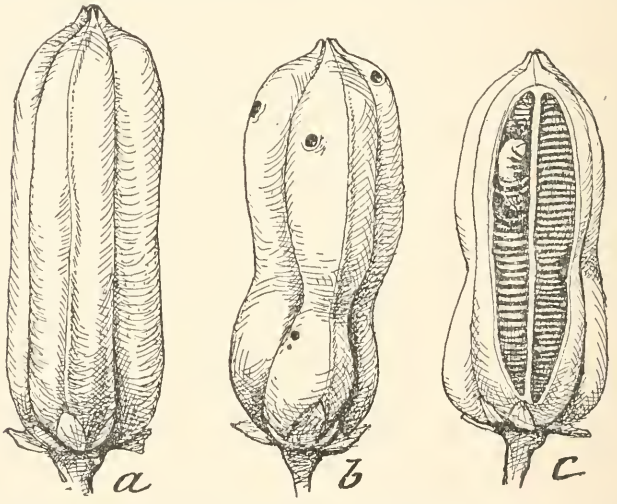

FIG. 9.—Mature pods of *Yucca angustifolia*: *a*, artificially pollinized and protected from Pronuba; *b*, normal pod, showing constrictions resulting from Pronuba puncture and exit holes of larva; *c*, one of the lobes cut open, showing larva within.

ing of *Yucca angustifolia*, but in the east, where these two species of Yucca are frequently grown side by side, *Y. angustifolia* flowers two or three weeks earlier than *Y. filamentosa* and generally too early to receive the visits of Pronuba, so that it produces seed only on very rare occasions. *Yucca brevifolia* is pollinized by *Pronuba synthetica* Riley, the most remarkable species of the genus, having very stout maxillary tentacles, a very stout ovipositor, shorter than that of *yuccasella*, but characterized chiefly by having fuliginous and unscaled wings and a polished, naked and flattened body—structures all well adapted for crawling between and about the compact and crowded flowers, with their

thick and leathery petals, but very abnormal in the Lepidoptera. In fact, this species strongly recalls in its general aspect some of the saw-flies belonging to the genus Dolorus, the resemblance being heightened by the rather conspicuous, cenchri-like spots, and by the conspicuous division between thorax and abdomen. It also strikingly recalls some of the Neuroptera, as *Sialis infumata*.

Now these resemblances to insects of different Orders and to families which are generally conceded to be of low type within their Order, cannot possibly be mimetic, as there can be no conceivable cause, purpose, or advantage in the mimicry. It is also impossible to account for these resemblances upon any present genetic connection. Yet we are hardly justified in disposing of them as merely accidental and without meaning. They suggest a possible synthesism in the past, when types were less specialized and present Orders had not become so well differentiated.

Yucca whipplei, which occurs in southern California, has flowers distinguished by their relatively long and stout stamens, the pollen of which is copious and glutinous, not to say mucilaginous, and a short, contracted style, with the stigma, however, expanded and covered with sticky threads. It is pollinized by *Pronuba maculata* Riley, which, as already shown, has a tongue modified into an accessory pollen-gathering organ. If any species of Yucca would seem not to need a special insect for pollination, *Yucca whipplei* is that species; for the long stamens, the sticky and abundant pollen, and the peltate, hairy stigma would all seem to facilitate ordinary pollination. Nevertheless, the very restricted style would seem to be purposely developed to counteract these other facilities, and we find a Pronuba associated with it, with a remarkably modified tongue, and with the maxillary tentacles very long and attenuated at the tip—structures which doubtless enable the moth to perform the act of pollination. I have never been able to observe the act, nor has any one yet recorded either the acts of pollination or oviposition. There will be nothing peculiar about the latter, but I shall be very glad to get actual experience in reference to the former, as I am satisfied that the observed facts will show, still more fully than in the case of *Pronuba yuccasella*, that the special modifications of both flower and insect have gone on until the mutual interdependence has become absolute.

There is much yet to learn of the pollination of other species of Yucca, and I am particularly anxious to obtain the insects which will doubtless be found associated with them. The regal

tree Yucca, *Yucca filifera*, of northeastern Mexico, reaching a height of fifty feet, with its pendulous panicles five or six feet long, has a very elongate pistil and comparatively short stamens. The few pods which I have been able to examine indicate the presence of a Pronuba and doubtless of a distinct species which will prove very interesting. *Yucca baccata*, *Y. treculiana*, and all the species which are sufficiently distinctive in characters and in range, may be expected to have special Pronubas associated with them.

The Bogus Yucca Moth.

An interesting fact connected with Pronuba and Yucca pollination is that there is always associated with *Pronuba yuccasella* another moth, which bears such a remarkable superficial resemblance to it, though possessing no power of pollination, that it has caused much confusion in the past on the part of careless observers and led to a good deal of misstatement and error. This is what I have called the Bogus Yucca Moth, *Prodoxus decipiens* (Fig. 10). In size it is somewhat smaller, on the average, than Pronuba, and, while found associated with it, appears rather earlier. The female has no maxillary tentacle, but otherwise the genus has all the characteristics which would place it in the same family as Pronuba. The ovipositor is a stronger instrument (Fig. 11), but structurally homologous. The eggs are thrust into the stem while yet tender; they are elongate in form, but short and rounded at both ends, resembling the undeveloped ova in the ovaries of Pronuba. The larva is absolutely apodous (Fig. 12, *a*), forms its cocoons within the stem, and transforms the ensuensuing year to a chrysalis, which has a much stronger capitate

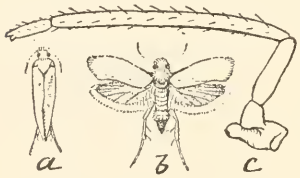

Fig. 10.—Prodoxus decipiens: *a*, imago, wings closed; *b*, female imago, wings expanded—natural size; *c*, enlarged maxillary palpus with its basal tubercle.

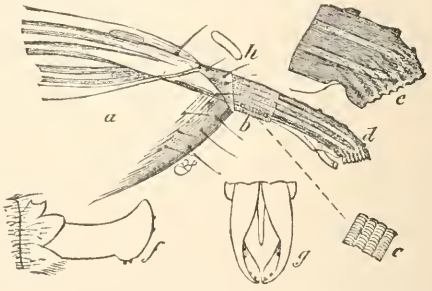

Fig. 11.—Genital characters of Prodoxus decipiens: *a*, tip of ♀ abdomen rendered somewhat transparent; *b*, basal joint of ovipositor; *c*, its sculpture; *d*, terminal joint of same, its tip more enlarged; *f*, genitalia of ♂ from side; *g*, do from above; *h*, egg.

spine, but the barest trace of dorsal spines on the abdominal joints. It issues partly from the stem in giving out the moth. As I have elsewhere remarked:

"Who, studying these two species in all their characters and bearing, can fail to conclude that, notwithstanding the essential differences that distinguish them not only specifically, but generically, they are derived from one and the same ancestral form? Pronuba, depending for its existence upon the pollination of the flower, is profoundly modified in the female sex in adaptation to the peculiar function of pollination. Prodoxus, dwelling in the flesh of the fruit or in the flower-stem and only indirectly

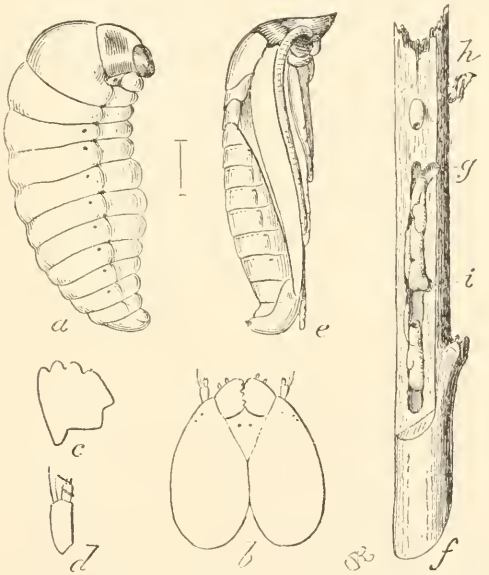

FIG. 12.—PRODOXUS DECIPIENS: *a*, larva: *b*, head from above: *c*, *d*, left jaw and antenna: *e*, pupa: *f*, infested stem cut open to show the burrows, castings, cocoons, and pupa shell (*h*)—all enlarged but *f*, the hair-line between *a* and *e* showing natural length.

depending upon the fructification of the plant, is not so modified, but has the ordinary characters of the family in both sexes. In the former the larva quits the capsules and burrows in the ground; it has legs to aid in its work, while the chrysalis is likewise beautifully modified to adapt it to prying through the ground and mounting to the surface. The latter, on the contrary—never quitting the stem—has no legs in the larva state and in the chrysalis state is more particularly adapted, by the

prominence of the capital projection, to piercing the slight covering of the stem left ungnawed by the larva. The former is very regular in its appearance as a moth at the time of the flowering of the Yuccas in their native range. The latter appears earlier, as the food of its larva is earlier ready, and the female could not oviposit in the riper stem."

Some ten species of this genus Prodoxus have been described, all of them having the very same structural characteristics and in the adolescent states being scarcely distinguishable. *Prodoxus decipiens* is associated with *Pronuba yuccasella* east of the Rocky Mountains, and *Prodoxus sordidus* is similarly associated with *Pronuba synthetica*, breeding in the flower stems of *Yucca brevifolia*. All the other species are associated with *Pronuba maculata*, breeding either in the base of the capsules or in the flower stem or the main stem of *Yucca whipplei*. I have found Prodoxus larvæ in the stems of all other Yuccas which I have been able to examine, and doubtless a number of other species are yet to be discovered and characterized. The species so far known are interesting in that they illustrate in a remarkable manner what I have called fortuitous variation, or superficial colorational characters; also a great tendency to graduate into each other by variations among themselves, not only in the structure of the ovipositor and the male genitalia but in the wing markings. The time to which these remarks are limited will prevent my going into descriptive details, and

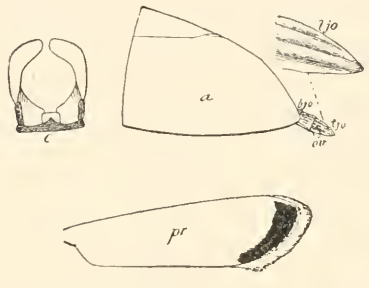

Fig. 13.—Prodoxus marginatus: *a*, anal abdominal joint of female — × 26; *b j o*, basal joint of ovipositor; *t j o*, terminal joint do.; *ov*, oviduct; *c*, claspers of male from above — × 18; *pr*, front wing—hair-line showing natural size.

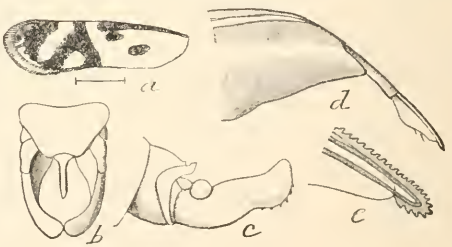

Fig. 14.—Prodoxus y-inversus: *a*, left front wing, hair-line underneath showing natural size; *b*, genitalia of male, dorsal view — × 14; *c*, do., lateral view — × 18; *d*, anal joint of female with ovipositor exserted, lateral view — × 20; *c*, tip of ovipositor still further enlarged.

I content myself with illustrating in this connection a few of the more distinctly marked species, Figs. 13, 14, 15, and 16. The genus interests us most, however, in indicating how Pronuba with all her abnormal, peculiarities, has been evolved; for though we have striking differences in habit and mode of development, of larva, pupa, and imago, between Pronuba and Prodoxus, yet the affinities are equally striking, and the two genera exemplify in an exceptional degree the power of natural selection to intensify habits and structures in opposing directions according to the requirements of the species. Prodoxus is practically dependent upon Pronuba, for if the latter did not fructify the plant, the former would have in time no flower stems to breed in, and while Prodoxus has gone on, generation after generation with comparatively little change, Pronuba has become profoundly specialized to fit it for a more specific purpose.

Fig. 15.—Prodoxus coloradensis: *a*, left front wing, hair-line underneath showing natural size; *b*, male genitalia, dorsal view — × 15; *c*, do., lateral view — × 18.

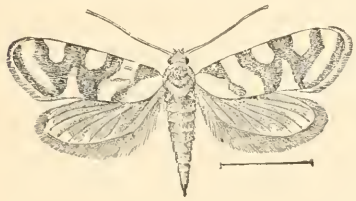

Fig. 16.—Prodoxus reticulatus: Female with wings expanded—hair-line showing natural size.

Caprification of the Fig.

It was my intention here to explain to you some interesting facts as to the caprification of the fig and the remarkable structural peculiarities and influence of the caprifig insects. It is, however, a somewhat complicated subject, and I could not within the time allotted me do justice both to it and the matter of Yucca pollination. As an indication, however, of how profoundly modified in this particular case the plant and the insect have become in their mutual adaptation, I may state that the perfect Smyrna fig, the most esteemed of the edible species, can be produced only by the intervention of the *Blastophaga psenes*, and that Dr. D. D. Cunningham has recently shown, in the Annals of the Royal Botanical Gardens of Calcutta, vol. I, Appendix I, 1889, by repeated examinations of the fruit of *Ficus roxburghii*, that pollination, in the ordinary meaning of that term, is, in that

particular case, out of the question, and that the development of the seed in this species is exclusively due to the stimulation of the tissues caused by the puncturing of the Blastophagas; in other words, that these insects actually represent the male element in the fertilization. This is certainly the most extraordinary phenomenon in the history of fertilization, and if confirmed—and Dr. Cunningham has been most careful and circumspect in his work—it will give a more striking instance than any we have hitherto obtained of the mutual interdependence which plants and insects may attain and the surprising manner in which they may modify each other.

Generalization.

The peculiarities which I have endeavored to present to you are full of suggestion, particularly for those who are in the habit of looking beyond the mere facts of observation in endeavors to find some rational explanation of them; who, in other words, see in everything they observe significances and harmonies not generally understood. The facts indicate clearly, it seems to me, how the peculiar structures of the female Pronuba have been evolved by gradual adaptation to the particular functions which we now find her performing. With the growing adaptation to Pronuba's help, the Yucca flower has lost, to a great extent, the activity of its septal glands; yet coincident with it we find an increase in the secreting power of the stigma. This increase of the stigmatic fluid has undoubtedly had much to do with originally attracting the moth thereto, while the pollinizing instinct doubtless became more and more fixed in proportion as the insect lost the power or desire of feeding. With the mind's eye I can look back into the past and picture the gradual steps by which the Prodoxids to which I have alluded have differentiated along lines which have resulted in their present characteristics. On the one side I see variations which have become sufficiently fixed to be considered specific; yet which can have no especial bearing on the life necessities of the species, but are a consequence rather of that universal tendency to variation with which every student of Nature becomes profoundly impressed. Thus the wing-markings vary from a darker general coloring, as in *Prodoxus æneascens*, to a more uniform intermixture of the black scales among the white, as in *cinereus*, or a sparser intermixture thereof, as in *pulverulentus*. The disposition of the black scales is in spots or bands, whether transverse or longitudinal, as in *marginatus*, *reticulatus*,

V-inversus, etc. These are fortuitous variations, for I cannot believe that the disposition of these marks where, as in these cases, they take every form that is conceivable, can be of any benefit to the species, any more than the mere variation in the number of lobes in the leaves of different oaks growing under like conditions can be of any particular benefit to the species, however useful to us in classification.

In my address before the Section of Biology of the American Association for the Advancement of Science, at Cleveland, in 1888, I have discussed the various forms and causes of variation, and especially the limitations of natural selection, stating expressly that this last "deals only with variations useful to the organism in its struggle for existence, and can exert no power in fixing the endless number of what, from present knowledge, we are obliged to consider fortuitous characters," and I have long recognized, from my studies of insect life, the existence of these fortuitous variations. The subject has since been very well elaborated by Professor Ward in his communication to the Society (December 15, 1888) on "Fortuitous variation as illustrated by the genus Eupatorium" and in his Annual Address (January 24, 1891) on "Neo-Darwinism and Neo-Lamarckism," and the Prodoxidæ furnish an excellent illustration of this fortuitous variation. Yet at the same time that we note this chance variation, as exemplified in a number of the species of Prodoxus, which are mere ravagers or despoilers and have not been brought into any special or mutual relations with the plant, we have, on the other hand, in *Pronuba yuccasella*, correlated with the other striking structural modifications which have brought it into such special relations with the plant, an elimination of all maculation or markings upon the primaries, and a purely white coloring so fixed that it shows absolutely no variation over half the continent. The structural variation has been necessary—a consequence of effort, environment, and natural selection. The color variation, on the contrary, has not been absolutely necessary, yet has nevertheless gone on in lines which, tending to give greater protective resemblance to the flower, have in the long run proved to be, perhaps, the most advantageous. I thus recognize three distinct lines of variation as exemplified in these Prodoxidæ, and what is true of them is, I believe, true of all alliances of organisms. The first and most important is structural and generic; it is absolutely essential and is preserved in its perfection by the elimination, through

natural selection, of all forms departing from it. The second is merely coincident, not essential, but nevertheless along lines that are of secondary advantage. The third is purely fortuitous, affects superficial features in the main, is unessential (a consequence of the inherent tendency of all things to vary), and takes place along all lines and in all directions where there is no counteracting resistance.

Now, when it comes to the bearing which the history of these little moths has upon some of the larger questions that are now concerning naturalists (for instance, the transmission of acquired characters, or the origin, development, and nature of the intelligence displayed by the lower animals), broad fields of interesting opinion and conclusion open up before us—fields that cannot possibly be explored without trenching too much upon your time. I will close, therefore, with a few summary expressions of individual opinion, without attempting to elaborate the reasons in detail, and with the object of eliciting further discussion, which is one of the objects of the paper. My first conviction is that insect life and development give no countenance to the Weissmann school, which denies the transmission of functionally acquired characters, but that, on the contrary, they furnish the strongest refutation of the views urged by Weissman and his followers. The little moths of which I have been speaking, and indeed the great majority of insects—all, in fact, except the truly social species—perform their humble parts in the economy of nature without teaching or example, for they are, for the most part, born orphans, and without relatives having experience to communicate. The progeny of each year begins its independent cycle anew. Yet every individual performs more or less perfectly its allotted part, as did its ancestors for generation after generation. The correct view of the matter, and one which completely refutes the more common idea of the fixity of instinct, is that a certain number of individuals are, in point of fact, constantly departing from the lines of action and variation most useful to the species, and that these are the individuals which fail to perpetuate their kind and become eliminated through the general law of natural selection.

Whether these actions be purely unconscious and automatic or more or less intelligent and conscious does not alter the fact that they are necessarily inherited. The habits and qualities that have been acquired by the individuals of each generation could have become fixed in no other way than through

heredity. Many of these acts, which older naturalists explained by that evasive word "instinctive," may be the mere unconscious outcome of organization, comparable to vegetative growth; but insects exhibit all degrees of intelligence in their habits and actions, and they perform acts which, however voluntary and, as I believe, conscious in many cases, as in that of our Yucca Moth, could not be performed were the tendency not inherited. Every larva which spins or constructs a hibernaculum, or a cocoon in which to undergo its transformations, exemplifies the potent power of heredity in transmitting acquired peculiarities. A hundred species of parasitic larvæ, *e. g.*, of the family Braconidæ, which in themselves are almost or quite indistinguishable from one another structurally, will nevertheless construct a hundred distinctive cocoons—differing in form, in texture, in color, and in marking—each characteristic of its own species and in many instances showing remarkable architectural peculiarities. These are purely mechanical structures, and can have little or nothing to do with the mere organization or form or structure of the larva, but they illustrate in the most convincing manner the fact that the tendency to construct and the power to construct the cocoon after some definite plan must be fixed by heredity, since there is no other way of accounting for it. This fact alone, which no one seems to have thought of in the discussion, should be sufficient to confound the advocates of the non-transmissibility of acquired characteristics.

Thus to my view modification has gone on in the past, as it is going on at the present time, primarily through heredity in the insect world. I recognize the physical influence of environment; I recognize the effect of the interrelation of organisms; I recognize, even to a degree that few others do, the psychic influence, especially in higher organisms—the power of mind, will, effort, or the action of the individual as contradistinguished from the action of the environment; I recognize the influence of natural selection, properly limited; but above all, as making effective and as fixing and accumulating the various modifications due to these or whatever other influences, I recognize the power of heredity, without which only the first of the influences mentioned can be permanently operative.

Let us stop for a moment to ponder what the intricate adjustments between plants and animals, and especially between plants and insects, mean, when these have become so profoundly modified by each other that their present existence actually de-

pends the one on the other. As palæontology shows, and as Professor Ward has more particularly so well explained, there was for ages no vegetation but the flowerless plants. The first were the low cellular cryptogams, consisting chiefly of marine algæ, and these, the lowest and first organisms upon the planet, have endured through all geologic time and obtain to-day. Next, beginning in the upper Silurian and reaching their maximum in the Carboniferous, came the vascular cryptogams, of which the ferns constituted the bulk. Arborescent and gigantic compared with present forms, they mingled with the now extinct Lycopodineæ to form the bulk of the forests of the coal period. Then came the Phænogams, or flowering plants, and in this great division the Cycadaceæ and coniferæ (pines, firs, etc.) were the chief forms during Mesozoic times. So far the seed has been exposed. Now come the Angiosperms, in which the seed is protected in the ovary or pericarp, and the Monocotyledons (palms, sedges, etc.) precede the Dicotyledons, while of these last the Apetalæ, Polypetalæ, and Gamopetalæ succeed each other in the order of their naming.

In brief, to use his own words, the development has been from the simple to the complex; from the flowerless to the flowering; from the endogenous to the exogenous; from the apetalous to the gamopetalous; and this succession corresponds to the best systems of classification of existing forms.

Both Cryptogams and Phænogams began existence during the Silurian, and there has been a race for supremacy ever since, with our present flora as the result. It is also a fact of the greatest significance that the same palæontological evidence which gives us this record also tells us that there has been a corresponding development of insect life, from the lower Neuroptera and Orthoptera, which prevailed in the days when Anemophilous plants reigned, to the higher Lepidoptera and Hymenoptera, which appeared only as the higher flowering plants developed in the Jurassic and Cretaceous.

I do not hesitate, in this connection, to refer to another of Professor Ward's conclusions set forth in one of his interesting articles, namely, that most of the higher flowering plants would speedily perish were insect aid withdrawn, and that but for such aid in the past we should now be without most of our gorgeous flora, and that insects have actually paved the way for man's existence by the part they have played in the development of fruit and nut bearing plants.

VOL. VII, PP. 105-132 JUNE, 1892

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

THIRD LIST OF ADDITIONS TO THE FLORA OF WASHINGTON, D. C.

BY THEODOR HOLM.*

The following list is supplemental to Professor Lester F. Ward's "Guide to the Flora of Washington and Vicinity,"† since the publication of which two additional lists have been issued.‡ The present paper covers the period from April 1, 1886, to April 1, 1892. The species which are new to the flora have been marked with an asterisk, but besides these many of the rarer species have been included, with records of new localities. The known flora has been increased by about 80 species and varieties since the year 1886. Some of the plants that are new to the District seem to have been accidentally introduced; for example: *Silene noctiflora*, *Althæa cannabina*, *Sida Napæa*, *Medicago maculata*, *Lespedeza striata*, *Veronica agrestis* and *V. hederæfolia*, *Brunella laciniata*, *Panicum miliaceum*, *Hordeum pratense*, etc. The others, however, are species indigenous to the United States which heretofore have been overlooked or which may

* Presented at a meeting of the Biological Society of Washington, May 14, 1892.

† Bulletin No. 22, U. S. National Museum, 1883.

‡ Ward, Proc. Biol. Soc., vol. II, 1885, pp. 84-87; Knowlton, *ibid.*, vol. III, 1886, pp. 103–132.

have immigrated from adjacent territory. In the latter category appear to be several species from the Potomac shore: *Ranunculus Pennsylvanicus*, *Flarkea proserpinacoides*, *Phacelia Corillei*, etc. The flora of the District is, however, probably not yet thoroughly known, and we need simply to recall the fact that a locality so rich as that near Silver Hill thus far seems to have escaped attention, and the river banks between Chain Bridge and Great Falls are yet far from being well explored.

It was the author's intention to give some additional notes in regard to the time of flowering, as many new facts have been reported; but these have not been included in the following list, because it has been found almost impossible to state with any certainty the true dates for many of the species in question. This is especially true of the spring flowers. In the year 1890, for instance, about forty species were found in bloom as early as the 15th of January, but in 1892 only a few were observed before the end of March.

It has been thought best to follow the nomenclature and arrangement of Professor Ward's Flora.

It is intended to continue the publication of lists of additions, and the botanists of Washington are requested to send to the author their notes upon species new to the District and upon new localities for rare plants.

RANUNCULACEÆ.

3. Clematis Virginiana L.

Anacostia road and Mill road, flowering in the first week of August. H. W. Henshaw.

***20*a*. Ranunculus Pennsylvanicus** L.

On the Virginia shore of the Potomac, just above Aqueduct Bridge; collected with flowers and fruit in the third week of August. The author.

***22*a*. Caltha palustris** L.

Flowering specimens brought to Center Market were said to have been collected in Anacostia River marsh at Bennings Bridge and three miles north of Bladensburg. The specimens referred to in Mr. Knowlton's list as collected in Rock Creek belong not to this species, but to *Ranunculus Ficaria* L. It is very

doubtful, however, whether these specimens were really found in the District.

26. Aconitum uncinatum L.

Woodley Park, first week of September. H. W. Henshaw.

BERBERIDACEÆ.

32. Berberis vulgaris L.

A tall shrub on the top of a hill between Eckington and Brookland. The author.

33. Caulophyllum thalictroides Michx.

Woodley Park. J. G. Gurley.

NYMPHÆACEÆ.

***38*a*. Nymphæa tuberosa** Paine.

Below the Alexandria turnpike bridge, Little Hunting Creek, Va. William Hunter.

SARRACENIACEÆ.

39 Sarracenia purpurea L.

Silver Hill. G. W. Oliver.

PAPAVERACEÆ.

40 Papaver dubium L.

On the canal embankment just above Outlet Lock. J. G. Gurley. Gravelly flat at the mouth of Cystopteris Run, below Chain Bridge. E. S. Burgess.

40*a*. Argemone Mexicana L.

Seventeenth street near Boundary. W. H. Seaman. Abundant in Brookland. The author.

CRUCIFERÆ.

47. Nasturtium silvestre R. Br.

Open lot east of the Navy Yard. Lester F. Ward. River margin at the stone quarry below Rhododendron Run. E. S. Burgess.

*49*a*. **Nasturtium palustre** DC. var. **hispidum** Fisch. & Mey.

Flats of the Potomac below Chain Bridge. G. B. Sudworth.

*50*a*. **Nasturtium sessiliflorum** Nutt.

Flats below Chain Bridge, May 29, 1890. G. B. Sudworth.

55. **Arabis dentata** Torr. & Gray.

Common on the Potomac shore just above Aqueduct Bridge, Virginia. The author.

70. **Sisymbrium Alliaria** Scop.

High Island. Miss Bebb.

72. **Camelina sativa** Crantz.

Several specimens were observed along the Chesapeake and Ohio Canal, east of High Island, in the third week of May. G. B. Sudworth.

74. **Brassica nigra** Koch.

Upon the rocks on the Virginia shore at Chain Bridge. The author.

78. **Thlaspi arvense** L.

Below the Insane Asylum. Lester F. Ward.

CISTACEÆ.

80. **Helianthemum Canadense** Michx.

Mount Hamilton. E. S. Burgess. Opposite Oak Hill Cemetery and at Bennings. G. W. Oliver.

VIOLACEÆ.

*89*b*. **Viola canina** L., var. **Muhlenbergii** Gray.

Fourteenth street road and Rock Creek, June, 1889. G. W Oliver.

*89*c*. **Viola odorata** L.

Near Accotink, Fairfax County, Virginia. William Hunter.

POLYGALACEÆ.

96. **Polygala incarnata** L.

Terra Cotta swamp and along the Queens Chapel road. Lester F. Ward and the author.

98. Polygala fastigiata Nutt.

Saul's nursery, Bladensburg turnpike. Lester F. Ward and the author.

99*a*. Polygala Curtissii Gray, var. **pycnostachya** Gray.

Abundant at Fort Myer. The author.

100. Polygala ambigua Nutt.

Common near Fort Ethan Allen. H. W. Henshaw. Linden Farm, Seventh and Eighth street roads, and Kalorama. E. S. Burgess. Brookland. The author. Fort Myer. H. W. Henshaw.

***100*a*. Polygala cruciata** L.

Very abundant in a sphagnum swamp near Silver Hill. G. W. Oliver.

***101*a*. Polygala verticillata** L.

Abundant near Fort Myer, flowering in the third week of August. H. W. Henshaw.

CARYOPHYLLACEÆ.

106. Silene nivea Otth.

Alexander Island, flowering in the last week of June. H. W. Henshaw. Gulf Landing, Potomac shore. G. B. Sudworth.

***107*a*. Silene noctiflora** L.

Columbia road, August. W. H. Seaman.

***110*a*. Lychnis vespertina** Sibth.

Numerous flowering specimens found in a meadow near Bunker Hill; first week of May, 1892. The author.

***117*a*. Stellaria graminea** L.

Abundant in the hedge of Chinese arbor-vitæ north of the conservatories, Department of Agriculture. George Vasey.

ILLECEBRACEÆ.

124*a*. Scleranthus annuus L.

West bank of Rock Creek, Georgetown. G. W. Oliver.

PORTULACACEÆ.

126, Claytonia Virginica L.

A double-flowered form observed at Beaver Dam Branch. Lester F. Ward.

* **126*a*. Talinum teretifolium** Pursh.

Dry moorland beyond Silver Hill. G. W. Oliver.

ELATINACEÆ.

* **126*b*. Elatine Americana** Arn.

Near Chain Bridge, on the Virginia shore of the Potomac, March, 1891. The author.

HYPERICACEÆ.

128. Ascyrum stans Michx.

Very common in several swamps near Silver Hill. G. W. Oliver. Accotink, Fairfax County, Virginia. William Hunter. Swamp back of Hyattsville. Lester F. Ward.

MALVACEÆ.

* **137*a*. Althæa cannabina** L.

Vacant lots south of the Capitol; escaped from cultivation. G. W. Oliver.

* **138*a*. Sida Napæa** Cav.

Potomac flats near the continuation of Eighteenth street; in flower during the first week of October. E. S. Burgess.

GERANIACEÆ.

* **151*a*. Flœrkea proserpinacoides** Willd.

High Island. M. B. Waite.

ILICINEÆ.

* **158*a*. Ilex glabra** Gray.

Swamp beyond Silver Hill. G. W. Oliver.

SAPINDACEÆ.

174. Acer saccharinum Wang.

A sapling of this, together with one of var. *nigrum*, neither in flower, was found on the second island in the Potomac above Feeder Dam Island. F. V. Coville.

LEGUMINOSÆ.

186. Baptisia australis R. Br.

Great Falls. H. W. Henshaw.

* **191*a*. Medicago maculata** Willd.

Fifteenth street, opposite the Panorama building. Miss A. M. Hayes. White House grounds. Countess Sponneck.

* **194*a*. Trifolium medium** L.

A single specimen found in an old sandy field between Georgetown and Alexandria. G. B. Sudworth.

195*a*. Trifolium hybridum L.

Monument grounds. Miss A. M. Hayes. Brookland, Soldiers Home, and near Fort Myer. The author.

* **195*b*. Trifolium incarnatum** L.

Several specimens collected in the city parks. C. S. Prosser.

* **220*a*. Lespedeza striata** L.

Railroad banks at the south end of Long Bridge; also along the Conduit road near the distributing reservoir. G. W. Oliver. Corcoran Woods. Lester F. Ward.

230. Clitoria Mariana L.

Abundant, with ripe fruits, Terra Cotta and Rock Creek. Lester F. Ward and the author.

ROSACEÆ.

* **257*a*. Rubus odoratus** L.

Several flowering specimens found in a damp, wooded ravine near the National Observatory, in the second week of June, 1890. G. B. Sudworth.

270. Poterium Canadense Benth. & Hook.

Swamp near Bladensburg. H. W. Henshaw. Holmead Swamp. Lester F. Ward and the author.

282. Cratægus Oxyacantha L.

Corcoran Woods; a single shrub. The author.

285. Cratægus parvifolia Ait.

Beyond Silver Hill. G. W. Oliver.

SAXIFRAGACEÆ.

289. Mitella diphylla L.

South bank of Cascade Run, near the mouth. E. S. Burgess.

291. Chrysosplenium Americanum Schwein.

Rock Creek, nearly opposite Crystal Spring. Lester F. Ward. Several places in the ravines above Aqueduct Bridge, on the Virginia shore. The author.

DROSERACEÆ.

300. Drosera rotundifolia L.

Sarracenia Swamp and near Fort Ethan Allen. H. W. Henshaw. Common in swamps east of Silver Hill. G. W. Oliver.

MELASTOMACEÆ.

***306*a*. Rhexia Mariana** L.

Near Accotink, Fairfax County, Virginia. William Hunter. Clearing in the pine woods, Marlborough road. G. W. Oliver.

LYTHRACEÆ.

307. Ammania humilis Michx.

Swamp in Piney Branch woods, and very common in swamps between Eckington and Brookland. The author.

ONAGRACEÆ.

***316*a*. Œnothera pumila** L.

Brentwood road, opposite Eckington. Lester F. Ward. Dry hills near Fort Myer; flowering in the second week of May. The author.

UMBELLIFERÆ.

342. Thaspium aureum Nutt.

Great Falls and above Aqueduct Bridge. The author.

ARALIACEÆ.

349. Aralia spinosa L.

Numerous small trees, but not flowering, near the Fort Myer road. Lester F. Ward.

350. Aralia nudicaulis L.

Rocks above the Promontory, Rock Creek. Lester F. Ward Rocks above Aqueduct Bridge, on the Potomac shore. Fr. Svendsen and the author.

352. Aralia trifolia Decsne.

Piney Branch below Fourteenth street bridge; with flowers in the third week of April. Countess Sponneck.

CAPRIFOLIACEÆ.

360. Viburnum nudum L.

Sphagnum swamp, Hensons Creek. G. W. Oliver.

***369*a*. Diervilla trifida** Moench.

Rock Creek. G. W. Oliver.

RUBIACEÆ.

372. Houstonia purpurea L., var. **longifolia** Gray.

Very common on the flats below Chain Bridge; also on rocks at Great Falls. The author.

374. Mitchella repens L.

The variety with white fruits has been collected by G. W. Oliver.

377. Galium asprellum Michx.

In woods near the Insane Asylum. Lester F. Ward and the author.

VALERIANACEÆ.

383*a*. Valerianella Woodsiana Walp.

High Island and the Canal bank below, May. F. V. Coville.

384. Fedia olitoria Vahl.

Massachusetts avenue extended. E. S. Burgess.

COMPOSITÆ.

***388*a*. Vernonia Noveboracensis** Willd., var. **latifolia** Gray.

Terra Cotta, Linnæan Hill, and Cascade Run. E. S. Burgess.

***398*a*. Eupatorium perfoliatum** L., var. **truncatum** Gray.

Woodley Park. E. S. Burgess.

***400*a*. Eupatorium aromaticum** L., var. **melissoides** Gray.

Woodley Park; in flower during the third week of September. E. S. Burgess.

402. Mikania scandens L.

Terra Cotta swamp. H. W. Henshaw and E. S. Burgess. Swamp near Queens Chapel road. Lester F. Ward and the author.

404. Liatris scariosa Willd.

A single specimen found above Chain Bridge, on the Virginia shore; flowering in the second week of October. E. S. Burgess.

415. Solidago rigida L.

Still persisting at Woodley Bridge, October, 1888. E. S. Burgess.

***415*a*. Solidago serotina** Ait.

Abundant near the second lock and near the Anacostia road beyond Sligo. H. W. Henshaw.

***423*a*. Solidago Canadensis** L., var. **scabra** Torr. & Gray.

Rock Creek; flowering in October. E. S. Burgess.

***423*b*. Solidago Canadensis** L., var. **procera** Torr. & Gray.

Near Spout Run. E. S. Burgess.

* **428*a*. Aster Shortii** Hook.

A mile above Aqueduct Bridge, on the shore of the Potomac, near Spout Run; in flower in the last week of October. E. S. Burgess.

* **428*b*. Aster azureus** Lindl.

Terra Cotta; flowering in the second week of October. E. S. Burgess.

430. Aster concolor L.

Terra Cotta swamp; in flower during the second week of October. E. S. Burgess. Rather common near the Reform School. Lester F. Ward and the author.

* **431*a*. Aster patens** Ait., var. **phlogifolius** Nees.

Woodley Park; in flower during the first week of October. E. S. Burgess.

432. Aster lævis L.

Still persisting in Woodley Park, October, 1888. E. S. Burgess.

435. Aster cordifolius L.

Just beginning to bloom in the last week of August. H. W. Henshaw.

* **444*a*. Aster puniceus** L., var. **lucidulus** (Wend.) Gray.

Terra Cotta. H. W. Henshaw.

446. Aster prenanthoides Muhl.

River bank near the storage-house of the Independent Ice Company. E. S. Burgess.

447. Aster oblongifolius Nutt.

Above Hydrophyllum Run. E. S. Burgess.

448. Aster Novæ-Angliæ L.

Woodley Park. J. J. Shirley. Potomac flats. Lester F. Ward and the author. Eighteenth street extended. Mouth of Foundry Run. Outlet Lock. E. S. Burgess.

450. Aster umbellatus Mill.

Terra Cotta swamp, near the railway track. Swamps below Freedman's Village. E. S. Burgess.

453. Erigeron bellidifolius Muhl.

Woodley Park. Lester F. Ward. Fort Totten. The author.

457. Baccharis halimifolia L.

Near Accotink Station, Virginia, on the Alexandria and Fairfax railway; flowering in the second week of September. William Hunter. Opposite Marshall Hall. G. W. Oliver.

***459*a*. Antennaria plantaginifolia** Hook., var. **monocephala** Gray.

Pierce's Mill Bridge, April 28, 1889. G. W. Oliver.

462. Gnaphalium purpureum L.

Potomac shore. Lester F. Ward. Common in Terra Cotta Swamp. Brookland. The author.

465. Silphium trifoliatum L.

Still persisting near Woodley Bridge, October, 1888. E. S. Burgess.

***465*a*. Silphium laciniatum** L.

At the southeastern end of Woodley Bridge; first discovered by J. W. Chickering; found more recently by E. S. Burgess.

***472*a*. Heliopsis scabra** Dun.

Near Spout Run; flowering in the first week of October. E. S. Burgess.

473. Eclipta alba Hassk.

Piney Branch, above the bridge at Fourteenth street. E. S. Burgess.

494*a*. Bidens connata Muhl.

Accotink, Fairfax County, Virginia. William Hunter.

497*a*. Galinsoga parviflora Cav.

Corner of Rhode Island avenue and S street. Piney Branch, above the bridge at Fourteenth street. E. S. Burgess. Massachusetts avenue, between Fourteenth and Fifteenth streets. The author.

* **502*d*. Artemisia caudata** Michx.

Near Alexandria; introduced. G. W. Oliver.

503. Arnica nudicaulis Ell.

Reform School. E. S. Burgess. Terra Cotta. Rock Creek. Queen's Chapel road. Bowen road. H. W. Henshaw.

* **513*a*. Cnicus pumilus** Torr.

Woodley Park. G. B. Sudworth.

* **524*a*. Hieracium Marianum** Willd.

Bank of the Potomac, opposite the south end of Analostan Island. E. S. Burgess.

* **529*a*. Lactuca Scariola** L.

This plant has lately been observed in several places within the city by Lester F. Ward, F. V. Coville, and the author.

LOBELIACEÆ.

537. Lobelia cardinalis L.

Holmead Swamp. Along the road between Cabin John Bridge and Great Falls. Near Corcoran Woods. Lester F. Ward and the author.

539. Lobelia puberula Michx.

Terra Cotta. The author.

CAMPANULACEÆ.

543. Campanula Americana L.

Cabin John Run. Miss Joyce Lee.

ERICACEÆ.

550. Epigæa repens L.

Autumnal flowers found in the last week of October. F. W. Clarke.

551. Gaultheria procumbens L.

Near Marlborough road. One mile above Blagden's Mill. G. W. Oliver.

558. Rhododendron viscosum Torr., var. **glaucum** Gray.

Swamp northwest of Terra Cotta. E. S. Burgess.

559. Rhododendron vizcosum Torr., var. **nitidum** Gray.

Swamp northwest of Terra Cotta. E. S. Burgess.

PYROLACEÆ.

564. Pyrola secunda L.

Near Chain Bridge, on the Virginia shore. The author.

PRIMULACEÆ.

577. Lysimachia nummularia L.

Along a stream near Terra Cotta. I. C. Williams and the author.

* **577*a*. Centunculus minimus** L.

Field opposite the white school-house at Woodlawn, along the Alexandria and Accotink turnpike; last week of June. William Hunter.

579. Samolus Valerandi L., var. **Americana** Gray.

Abundant above and below Chain Bridge. Along the Potomac below Analostan Island. G. B. Sudworth.

APOCYNACEÆ.

585. Vinca minor L.

Back of Uniontown, along a stream in a hedge of *Smilax;* thoroughly established. Lester F. Ward. Hillside in South Brookland. The author.

585*a*. Apocynum androsæmifolium L.

Between Corcoran Woods and the Baltimore and Ohio Railroad. Lester F. Ward and the author.

ASCLEPIADACEÆ.

594. Asclepias obtusifolia Michx.

Anacostia River below the bridge. Reform School. Terra Cotta. E. S. Burgess.

595. **Asclepias variegata** L.

Terra Cotta. Reform School. E. S. Burgess. Fort Myer. The author.

596. **Asclepias quadrifolia** Jacq.

Chamælirium Run, E. S. Burgess.

597. **Asclepias verticillata** L.

Cascade Run. E. S. Burgess. Rock Creek. Great Falls. Lester F. Ward and the author.

599. **Enslenia albida** Nutt.

Abundantly flowering under Chain Bridge, in the middle of July. Lester F. Ward and the author.

600. **Gonolobus obliquus** R. Br.

Bluffs of the Potomac, at two localities between M. E. Church and Chain Bridge. H. W. Henshaw and E. S. Burgess.

LOGANIACEÆ.

*601*a*. **Spigelia Marilandica** L.

In a moist thicket in the vicinity of Mount Vernon; flowering in June, 1890. G. B. Sudworth.

GENTIANACEÆ.

*602*a*. **Sabbatia gracilis** Salisb.

Low meadow east of Falls Church. C. Kinsley.

604. **Gentiana Andrewsii** Griseb.

Flats between Aqueduct and Chain bridges. Lester F. Ward and the author. Terra Cotta Swamp. Lester F. Ward.

607. **Obolaria Virginica** L.

Rock Creek. G. W. Oliver. Several places in North Brookland. The author.

POLEMONIACEÆ.

608. **Phlox paniculata** L.

Great Falls. Lester F. Ward and the author.

609. Phlox maculata L.

Near Chain Bridge, on the Virginia shore. Terra Cotta Swamp. The author.

613. Polemonium reptans L.

Munson Hill. H. W. Henshaw.

HYDROPHYLLACEÆ.

615. Ellisia Nyctelea L.

Poplar Point. E. S. Burgess. On the Potomac shore, Virginia side, near Aqueduct Bridge. The author.

615*a*. Phacelia Covillei Wats.

Larkspur Island. Lester F. Ward, F. V. Coville, and M. B. Waite.

616. Phacelia Purshii Buckl.

High Island. Lester F. Ward. On the Virginia shore of the Potomac, near Aqueduct Bridge. The author.

617. Phacelia parviflora Pursh.

Great Falls; observed in great abundance. The author. Analostan Island and High Island. G. B. Sudworth.

CONVOLVULACEÆ.

630. Ipomæa coccinea L.

Vacant lot near the Baptist Church, southeast corner of Rawlin's Square. E. S. Burgess.

635. Convolvulus spithamæus L.

Reform School. E. S. Burgess.

***636*a*. Convolvolus sepium** L., var. **Americanus**.

Near Aqueduct Bridge, on the Virginia shore. The author.

640*a*. Cuscuta compacta Juss.

Near Fort Myer. The author.

SOLANACEÆ.

*641*a*. **Solanum Dulcamara** L.

Hedgerow a short distance west of the railroad below Alexandria. G. W. Oliver.

643. **Physalis pubescens** L.

Still persisting in Lobelia Run, Woodley Park. E. S. Burgess.

*643*a*. **Physalis Philadelphica** L.

Woodley Park. G. B. Sudworth.

SCROPHULARIACEÆ.

651. **Linaria Canadensis** Dumont.

Abundant in dry fields near Terra Cotta. I. C. Williams and the author.

654. **Scrophularia nodosa** L.

Virginia shore near Spout Run. E. S. Burgess. Cascade Run. Lester F. Ward. Flats below Chain Bridge. The author.

656. **Pentstemon pubescens** Soland.

Virginia shore of the Potomac above the Dixie Landing. Mount Hamilton. E. S. Burgess. Mouth of Cystopteris Run. H. W. Henshaw.

657. **Pentstemon lævigatus** Soland.

Mouth of Cystopteris Run. H. W. Henshaw. High Island. Near Great Falls. E. S. Burgess. Corcoran Woods. Near Fort Myer. The author.

666 **Veronica Americana** Schwein.

Goldianum Run. Lester F. Ward.

669. **Veronica serpyllifolia** L.

Woodlawn, Fairfax County, Virginia. William Hunter.

*669*a*. **Veronica agrestis** L.

Accotink, Fairfax County, Virginia. William Hunter. The plant was collected in full bloom in the first week of February.

***671*a*. Veronica hederæfolia** L.

Smithsonian grounds; in flower in the last week of April. H. M. Smith.

672. Buchnera Americana L.

East of Cabin John Bridge. H. W. Henshaw. , Terra Cotta. Lester F. Ward and the author.

675. Gerardia quercifolia Pursh.

Fort Myer. H. W. Henshaw.

676. Gerardia purpurea L.

A white-flowered variety, collected near Woodlawn, Fairfax County, Virginia. William Hunter.

OROBANCHEÆ.

681. Orobanche minor L.

Mount Vernon Square, near Terra Cotta. E. S. Burgess. Piney Branch woods. The author.

682. Aphyllon uniflorum Gray.

Chamælirium Run. E. S. Burgess. Insane Asylum woods. Near Aqueduct Bridge, on the Virginia shore. The author. Bull Run River, Virginia. Rock Creek. H. W. Henshaw.

LABIATÆ.

713. Pycnanthemum muticum Pers.

Queen's Chapel road and near Fort Myer. H. W. Henshaw.

725. Lophanthus nepetoides Bth.

Fort Bennett. H. W. Henshaw.

***734*a*. Brunella laciniata** L.

South bank of the Potomac, in a pasture a few hundred yards west of the uppermost steamboat landing above Aqueduct Bridge; flowering in the second week of July. F. V. Coville.

738*a*. Lamium purpureum L.

Agricultural grounds. G. B. Sudworth.

PLANTAGINEÆ.

745. Plantago Patagonica Jacq., var. **aristata** Gray.

Woodley Park. G. B. Sudworth.

POLYGONACEÆ.

773*a*. Polygonum tenue Michx.

Lanier Heights. E. S. Burgess.

***775*a*. Polygonum Hartwrightii** Gray.

Potomac flats just below Outlet Lock; not seen in flower. F. V. Coville.

ARISTOLOCHIACEÆ.

788. Aristolochia Serpentaria L.

Seven Locks. E. S. Burgess. Observed in several places in woods, but always scattered. Lester F. Ward, G. W. Oliver, and the author.

LORANTHACEÆ.

794. Phoradendron flavescens Nutt.

Growing upon *Acer rubrum*, *Quercus tinctoria*, and *Q. coccinea*. Woodlawn, near Mount Vernon, Virginia. William Hunter. On *Acer rubrum*, five miles west of Falls Church, Virginia. Lester F. Ward.

EUPHORBIACEÆ.

800. Euphorbia commutata Eng.

Cystopteris Run. E. S. Burgess. Virginia shore of the Potomac above Aqueduct Bridge. The author.

801. Phyllanthus Carolinensis Walt.

Rediscovered in Corcoran Woods. G. W. Oliver.

URTICACEÆ.

816. Parietaria Pennsylvanica Muhl.

In a thicket between Aqueduct Bridge and Chain Bridge, near the Canal road. Lester F. Ward and the author.

JUGLANDACEÆ.

818. Carya alba Nutt.

One large tree, standing on the north side of the Braddock road near Back Lick Run, opposite the *Ophioglossum* grounds. Lester F. Ward.

MYRICACEÆ.

825. Myrica cerifera L.

Sphagnum swamp beyond Silver Hill. G. W. Oliver. North Brookland. Robert Ridgway.

CUPULIFERÆ.

831*a*. Quercus alba × obtusiloba.

Near Silver Spring. H. W. Henshaw.

831*b*. Quercus alba × Prinus.

Rockville road opposite Oakview. H. W. Henshaw.

***833*a*. Quercus lyrata** Walter.

About one hundred yards east of High Island, near the Potomac River. G. B. Sudworth.

835. Quercus Michauxii Nutt.

Above the Silver Hill road. Lester F. Ward. Owl Bridge, Northwest Branch of Paint Branch, Maryland. H. W. Henshaw.

836*a*. Quercus Prinus × alba.

Brightwood. H. W. Henshaw.

837. Quercus Muhlenbergii Engelm.

Blagden's Mill. Bluffs above the canal road west of Chain Bridge. Broad Branch. First run east of Cabin John Bridge. H. W. Henshaw.

838. Quercus prinoides Willd.

Bladensburg road. H. W. Henshaw.

*840*a*. **Quercus coccinea × falcata.**

Brightwood, between Bunker Hill road and Brentwood road. H. W. Henshaw.

*842*a*. **Quercus falcata × tinctoria.**

Le Droit Park. H. W. Henshaw.

848. **Quercus Leana** Nutt.

Cabin John Bridge. H. W. Henshaw.

849. **Quercus heterophylla** Michx.

Fort Bennett. H. W. Henshaw.

ARACEÆ.

874. **Arisæma Dracontium** Schott.

Near Spout Run. E. S. Burgess. Great Falls, on the Maryland side. Lester F. Ward and the author.

LEMNACEÆ.

*879*a*. **Lemna gibba** L.

Old canal, foot of Eighteenth and Twentieth streets. Lester F. Ward.

NAIADACEÆ.

884. **Najas flexilis** Rostk.

Several fruiting specimens were collected in the *Brasenia* pond near Chain Bridge. G. W. Oliver.

887. **Potamogeton hybridus** Michx.

Alexandria. G. W. Oliver.

*888*a*. **Potamogeton Robbinsii** Oakes.

Hunting Creek, Virginia. F. V. Coville.

ORCHIDACEÆ.

900. **Orchis spectabilis** L.

Several places in the woods above Aqueduct Bridge, on the Virginia shore. The author. Near the first bridge over Rock Creek on Connecticut avenue extended. G. B. Sudworth.

901. Habenaria tridentata Hook.

Beyond Silver Hill. G. W. Oliver.

909. Spiranthes gracilis Bigel.

Smithsonian Park. Piney Branch. Eastern Branch woods. The author.

914. Tipularia discolor Nutt.

North Brookland. Robert Ridgway. Fort Myer. The author.

915. Microstylis ophioglossoides Nutt.

Sandy Spring road; a single specimen. H. W. Henshaw. Near Blagden's Mill. P. Gauges.

917. Liparis Lœselii Rich.

North end of Massachusetts Avenue bridge. G. W. Oliver.

919. Corallorhiza multiflora Nutt.

Below Burnt Mills; four specimens in flower in the second week of August. H. W. Henshaw.

HÆMODORACEÆ.

925. Aletris farinosa L.

Fort Whipple; above Blagden's Mill. H. W. Henshaw. Silver Hill. G. W. Oliver and M. B. Waite.

IRIDACEÆ.

927. Iris verna L.

Bladensburg. M. B. Waite.

LILIACEÆ.

946. Smilacina stellata Desf.

About forty specimens in full bloom, besides several younger individuals, were observed on a shaded rock about three miles above Aqueduct Bridge, on the Virginia shore, in the second week of May. The author.

947. Maianthemum Canadense Desf.

Swamp near the Reform School. G. W. Oliver.

*949*a*. **Lilium Philadelphicum** L.

Broad Branch. H. W. Henshaw. Glen Echo. W. H. Abbott.

956. **Melanthium Virginicum** L.

Several specimens brought to Center Market were said to have been collected near Alexandria.

957. **Veratrum viride** Ait.

Like the preceding, brought to the market from near Alexandria.

*961*a*. **Ornithogalum nutans** L.

Rock Creek, Pierce's Mill Run; last week of April. G. Brown Goode and H. W. Henshaw. Meadow east of Foundry Run. F. V. Coville.

COMMELINACEÆ.

983. **Commelina Virginica** L.

Bank near Chain Bridge, on the Virginia shore. H. W. Henshaw.

XYRIDACEÆ.

985. **Xyris flexuosa** Muhl.

Meadow beyond Silver Hill. Swamp near the Reform School. G. W. Oliver.

ERIOCAULONACEÆ.

986. **Eriocaulon decangulare** L.

Silver Hill. G. W. Oliver.

CYPERACEÆ.

986*b*. **Cyperus flavescens** L.

Abundant along streams in the Piney Branch woods. Near Chain Bridge. The author.

994. **Cyperus Michauxianus** Schult.

Pond near Chain Bridge. The author.

998. Cyperus retrofractus Torr.

Mount Hamilton. Lester F. Ward and the author. Along the Canal road. The author.

***1003*a*. Eleocharis olivacea** Torr.

Holmead Swamp; flowering in the last week of September. The author.

***1003*b*. Eleocharis tuberculosa** R. Br.

Holmead Swamp; abundant. The author.

1010. Scirpus debilis Pursh.

Abundant in swamps near Cabin John Bridge. The author.

1017. Eriophorum Virginicum L.

Swamp beyond Silver Hill. G. W. Oliver.

***1021*a*. Rhyncospora cephalantha** Gray.

Holmead Swamp. The author.

***1021*b*. Rhyncospora macrostachya** Torr.

Accotink, Fairfax County, Virginia. William Hunter.

***1021*c*. Rhyncospora corniculata** Gray.

Sandy Landing, Maryland. Lester F. Ward.

1022. Scleria triglomerata Vahl.

Terra Cotta Swamp. The author. Reform School. G. W. Oliver.

1024. Scleria pauciflora Muhl.

Terra Cotta Swamp. Saul's nursery on the Bladensburg turnpike. Along the Anacostia river marsh. The author.

***1024*a*. Scleria reticularis** Michx.

Holmead Swamp, September. F. V. Coville.

1031*a*. Carex muricata L.

Smithsonian Park. The author.

*1031*b*. **Carex divulsa** Good.

North Brookland. The author.

1055. **Carex glaucodea** Port.

Near the Insane Asylum. Lester F. Ward and the author.

1083. **Carex vestita** Willd.

Terra Cotta Swamp. The author.

1093. **Carex stenolepis** Torr.

Common on the flats between Aqueduct and Chain bridges. Swamp near the Insane Asylum. Above Aqueduct Bridge, on the Virginia shore. The author.

GRAMINEÆ.

1101*a*. **Sporobolus vaginæflorus** Torr.

Common in gardens in the northern part of the city. The author.

1112. **Muhlenbergia capillaris** Kth.

Rediscovered in the old locality near Great Falls; flowering in the third week of September. Lester F. Ward and the author.

*1114*a*. **Calamagrostis Canadensis** Beauv.

On the edge of a swamp, Accotink, Fairfax County, Virginia. William Hunter.

1121. **Gymnopogon racemosus** Beauv.

In thickets along the Queen's Chapel road. Lester F. Ward and the author.

1153*a*. **Bromus tectorum** L.

Open, dry hillside near Anacostia. The author.

1158. **Uniola gracilis** Michx.

Terra Cotta Swamp. Lester F. Ward and the author.

* **1160*b*. Hordeum pratense** Huds.

Accotink, Fairfax County, Virginia. William Hunter.

* **1166*a*. Danthonia sericea** Nutt.

A few specimens collected in June, 1890, west of Tennallytown. G. B. Sudworth.

1185. Panicum microcarpon Muhl.

Rock Creek. Lester F. Ward and the author.

1190. Panicum verrucosum Muhl.

Holmead and Terra Cotta swamps. Lester F. Ward and the author.

* **1192*a*. Panicum miliaceum** L.

Monument grounds. The author.

1195*a*. Setaria Italica Kth.

Near Ivy City. G. W. Oliver.

1203. Andropogon macrourus Michx.

Terra Cotta Swamp. Lester F. Ward and the author.

CONIFERÆ.

1207. Pinus pungens Michx.

Johnny Moore Creek, Virginia. Near Woodlawn, Virginia. William Hunter. Barnaby Branch, Soldiers' Home. Lester F. Ward.

* **1207*a*. Pinus Tæda** L.

Near Brightwood. B. E. Fernow.

* **1207*b*. Pinus glabra** Walter.

A single tree, about 35 feet high, in a ravine near Tennallytown; apparently introduced. G. B. Sudworth.

1210. Pinus Strobus L.

Near Long Bridge. William Hunter.

1211. Tsuga Canadensis Carr.

Accotink Creek, Virginia. William Hunter.

FILICES.

1216. Pellæa atropurpurea Link.

Causeway between Analostan Island and the Virginia shore. E. S. Burgess. Rock Creek, between Pierce's Mill and Broad Run. G. W. Oliver.

1219. Woodwardia angustifolia Sm.

Piney Branch woods. Near the Reform School. Lester F. Ward and the author.

1223. Asplenium angustifolium Michx.

Above Blagden's Mill, on the west bank of Rock Creek. G. W. Oliver.

1226. Camptosurus rhizophyllus Link.

Mount Vernon. William Hunter.

1239. Dicksonia pilosiuscula Willd.

Abundant along Rock Creek. Lester F. Ward and the author.

1245. Botrychium ternatum Swz., var. **dissectum** Millde.

In the wood near Aqueduct Bridge, on the Virginia shore. The author.

1247. Ophioglossum vulgatum L.

Very plentiful in woods near Bennings. P. Gauges. A single specimen collected near the Reform School. Lester F. Ward and the author.

LYCOPODIACEÆ.

***1248*b*. Lycopodium alopecuroides** L.

Sphagnum swamp, Henson's Creek. G. W. Oliver.

1248*c*. Lycopodium annotinum L.

In the same locality as the preceding. G. W. Oliver.

1249. Lycopodium dendroideum Michx.

Near the Reform School. Lester F. Ward and the author. North Brookland. Robert Ridgway.

1253. Selaginella apus Spring.

Common in Piney Branch woods, Holmead Swamp, Rock Creek, and in the ravines on the Virginia shore, between Aqueduct and Chain bridges. The author. Kalorama. *Chamælirium* Run. E. S. Burgess.

ISOËTEÆ.

***1253*b*. Isoëtes riparia** Engelm.

Hunting Creek, near Alexandria. F. V. Coville.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

PLANTS OF THE PRIBILOF ISLANDS, BERING SEA.*

BY DR. C. HART MERRIAM.

WITH CRITICAL NOTES BY J. N. ROSE.

INTRODUCTORY NOTE.

The present incomplete list of the plants of the Pribilof or Seal Islands is based on specimens collected by me from July 28 to August 10, 1891, and presented to the National Herbarium in the United States Department of Agriculture. The collection consists of about 1,000 specimens in good condition, comprising upwards of 130 species. Several collections of plants have been made on the islands before, but owing to the constant fogs were ruined by dampness and mould before reaching Washington. My plants were dried by artificial heat and kept in a dry place on the United States Fish Commission Steamer 'Albatross' until their arrival at Puget Sound, whence they were transmitted promptly to Washington by rail.

So far as I am aware, no previous list of the plants of these islands has appeared, though the Pribilof Islands are mentioned as a locality under a number of species in 'Flora Rossica,' and Townsend enumerates 12 species that were brought back by him and identified by Dr. George Vasey.† The present list cannot

* Read before the Biological Society of Washington, May 28, 1892.

† Cruise of the *Corwin* for 1885, 1887, p. 97.

be anything like complete, since I was on the islands altogether only two weeks and botanizing was incidental to more urgent duties; moreover, only limited parts of the islands were traversed, and the date (end of July and early August) was so late that many plants were past flowering. On several rambles I had the good fortune to be accompanied by Mr. James M. Macoun, of the Geological and Natural History Survey of Canada, who will doubtless supplement my list by many additional records, particularly from St. George Island, where my opportunities for collecting were reduced to a minimum. No collecting was done on Walrus or Otter Islands.

Acknowledgments for the Determination of Species.

The majority of the flowering plants were identified by me on the islands. The entire collection on its arrival in Washington was examined by Dr. George Vasey, Botanist of the United States Department of Agriculture, and was turned over by him to Mr. J. N. Rose, Assistant Botanist, for critical study. Mr. Rose has gone over the collection, verifying and supplementing my determinations, and has contributed critical notes on four species, which are inserted in brackets over his initials. Special groups have been submitted to specialists for determination as follows: The *willows* have been identified by Dr. M. S. Bebb; the *grasses* by Dr. George Vasey; the *Carices* by Prof. L. H. Bailey; the *Juncaceæ* by Mr. F. V. Coville; the *mosses* except the *Sphagnums* by Mrs. E. G. Britton, Mr. John M. Holzinger, and Dr. V. F. Brotherus, of Helsingfors, Finland; the *Sphagnums* by Dr. C. Warnstorf, of Neuruppin, Germany; and the *Hepatica* by Prof. L. M. Underwood. Six species of mosses collected on St. Paul Island by Mr. Macoun during our visit have been described as new by Dr. H. C. Kindberg.*

Brief Description of the Pribilof Islands with Special Reference to their Vegetation.

The Pribilof group in Bering Sea is about 350 kilometers (220 miles) north of the Aleutian Chain, and comprises the islands St. Paul and St. George, separated by about 64½ kilometers (40 miles) of sea, and two islets known as Walrus and Otter Islands,

* Ottawa Naturalist, vol. v, p. 179; separates issued January 12, 1892.

near St. Paul. St. Paul is the largest, measuring about 23½ kilometers (14 miles) in length by 12 kilometers (7½ miles) in greatest breadth; St. George is a little less than 19.3 kilometers (12 miles) in length by a little more than 8 kilometers (5 miles) in greatest breadth. The highest land is on St. George, where a precipitous cliff fronting the sea and a hill in the interior exceed 275 meters (900 feet). The highest land on St. Paul is a little over 183 meters (600 feet). The group is of volcanic origin, and the general surface is rolling, with precipitous cliffs along the water front in many places, alternating with broad valleys and basins. The cliffs predominate on St. George. In summer the islands are almost constantly enveloped in fog; the atmosphere is saturated (the wet and dry bulbs registering the same), and the temperature is uniformly low, the thermometer ranging from 7° C. (= 45° F.) to 9° C. (= 48° F.) or rarely 10° C. (= 50° F.). A good many snow-banks were conspicuous on St. George at the time of our visit, and a few remained in sheltered places on St. Paul. Level moss-bogs and small fresh-water ponds abound, but the greater part of each island consists of extensive stretches of sloping or hilly land thickly strewn with volcanic rocks ½ meter to 2 meters (1½ to 6 feet) in diameter, with innumerable pit-holes between them.

On nearing the islands, if the fog lifts a little, the visitor is impressed by the luxuriance and intensity of color of the deep-green or yellowish-green vegetation which completely covers the surface, as in the case of the less precipitous slopes of the Aleutian Chain. This vegetation consists chiefly of rank grass and bog-moss, interspersed with multitudes of beautiful and showy flowers, which are numerous enough to give color to large areas. There is not a tree or bush on either island, and the highest woody plant—a dwarf willow (*Salix reticulata*)—hardly reaches the height of 75 mm. (3 inches) above the moss-bed in which it grows. Many of the side hills and flats are buried waist deep in a dense growth of rank rye grass (*Elymus mollis*) and cow parsnip (*Heracleum lanatum*), called 'poochka' by the native Aleuts. A coarse but pleasing lupine (*Lupinus nootkatensis*), averaging nearly 1 meter (3 feet) in height and very bushy, is abundant in most parts of the islands, often growing in company with the handsome monkshood (*Aconitum delphinifolium*), which, together with the beds of *Polemonium cæru-*

leum, cover nearly half the green carpet with blue and purple blossoms. Interspersed among the blue flowers just mentioned, and frequently forming large patches by itself, is the pink or pinkish-purple *Pedicularis langsdorffii*. Then there are acres of the showy Alaska poppy (*Papaver nudicaule*), the individual plants standing near enough together to give a delicate yellow glow to the areas they cover. In places the moss and heather bogs are blue from the abundance of blue bells (*Campanula lasiocarpa*), whose disproportionately large flowers actually recline on the moss through which their short stems rise, while another species of the same genus (*C. pilosa*) is inconspicuous and easily overlooked. Other bogs are covered with the deep yellow flowers of *Geum rossii*. A blue violet (*Viola langsdorfii*), a blue and white gentian (*Gentiana frigida*), a spring beauty (*Claytonia arctica*), the Alaska oxeye (*Chrysanthemum arcticum*), a dwarf cornel (*Cornus unalaschensis*), and the pretty white star-flower (*Trientalis arctica*) are common in places on the moss-bogs, and sometimes grow in the grass also. Beds of *Omphalodes nana chamissonis* and *Silene acaulis* are common in spots, especially about Bogoslof hill and Polavina, but were mostly past flowering at the time of my visit. Several species of saxifrage are common, the most conspicuous being *S. hircalus*, whose rich, deep-yellow blossoms are much admired.

The raspberries are represented by two dwarf species, *Rubus stellatus* and *R. chamæmorus;* the former was in full bloom and the latter in fruit. The beautiful sea vetch (*Lathyrus maritimus*) abounds in a few spots, but is not generally distributed, and the showy lungwort (*Mertensia maritima*) is common at Northeast Point on St. Paul, and was found sparingly in a few other places, always along the shore. *Primula nivalis* is common in a depression at the mouth of a large cave on Bogoslof hill, but was not found elsewhere on St. Paul.

Ferns are rather scarce, though several species occur. The prevailing moss of the moss-bogs is *Racomitrium lanuginosum*. *Sphagnum* is scarce on St. Paul, but common on the low bogs of St. George. Heather (*Empetrum nigrum*) abounds on both islands, forming extensive beds—sometimes pure, but usually mixed with moss. Its black umbilicated berries were ripening early in August. Two species of *Lycopodium* occur, but are not common.

List of Plants Collected on the Pribilof Islands in July and August, 1891.*

Anemone richardsoni Hooker.

Flowering specimens collected on St. Paul August 7. Not common.

Ranunculus flammula reptans Meyer.

Common about the edges of fresh-water ponds on St. George. Collected in flower August 10.

Ranunculus eschscholtzii Schlecht.

Found in flower among rocks near Bogoslof hill, St. Paul, August 7.

Ranunculus hyperboreus Rottb.

Found in flower on both St. Paul and St. George.

Aconitum delphinifolium Reich.

Abundant on both islands; in full bloom during the latter part of July and early August. Those growing in the moss-bogs are smaller and more delicate than those on higher and drier ground.

Papaver nudicaule Linn.

Abundant on both islands; sometimes scattered here and there in the grass among other equally conspicuous flowers, but often growing in large beds on the moss and heather bogs, covering acres with handsome yellow flowers, which are of large size; at height of blooming the last week of July; petals falling early in August.

Cardamine hirsuta Linn.

Abundant on both islands.

* Respecting the localities assigned, it should be borne in mind that most of the collecting was done on St. Paul Island; hence a large number of the species here attributed to St. Paul alone doubtless occur in equal abundance on St. George.

Draba incana Linn.

Tolerably common on St. Paul.

Cochlearia officinalis Linn.

Common on St. Paul; in full flower.

Cerastium alpinum Linn.

Common on both islands; in full flower.

Cerastium arvense Linn.

Collected on St. Paul Island by Townsend in 1885 and identified by Dr. Vasey.

Viola langsdorfii Fischer.

Common on both islands; at height of flowering about the end of July.

Silene acaulis Linn.

Common in small patches, particularly on rocky hillsides; past prime.

Lychnis apetala Linn.

Common on St. Paul.

Stellaria crassifolia Ehrh.

Collected on St. George August 10.

Stellaria humifusa Rottb.

Rather common on St. Paul.

Stellaria media Smith.

Common on St. Paul.

Arenaria macrocarpa Pursh.

Abundant on the heather and moss bogs on both islands. Flowers large, white.

Arenaria peploides oblongifolia Watson.

Common in moss bogs near Polavina on St. Paul.

Sagina linnæi Presl.

Common on both islands.

Claytonia arctica Adams.

Common on St. Paul; in full bloom the end of July.

Montia fontana Linn.

Tolerably common on St. Paul.

Lupinus nootkatensis Donn.

Very abundant and conspicuous on both islands; grows high and rank; flowers past prime before end of July.

Lathyrus maritimus Bigel.

Common in a few places on St. Paul; in full flower July 30.

Rubus chamæmorus Linn.

Abundant on both islands, particularly on the heather bogs. Fruit full grown but imperfect and not ripe the latter part of July.

Rubus stellatus Smith.

Common on the heather bogs of both islands. In full bloom the latter part of July; flowers deep, rich red.

Geum rossii Seringe.

Abundant on both islands and growing in the moss bogs in patches a meter or two in diameter. A little past prime in early August. The deep yellow flowers are showy and handsome.

Potentilla fragiformis Willd.

Common on St. Paul; past prime.

Potentilla palustris Scop.

Common in some of the sphagnum bogs on St. George; in flower the first week in August.

Saxifraga bracteata Don.

Common on St. Paul.

Saxifraga chrysantha Gray.

Common in places near Bogoslof hill on St. Paul. Its rich yellow flowers are conspicuous, though considerably smaller than those of *S. hirculus*.

Saxifraga hieracifolia Waldst. & Kit.

Common in places on St. Paul.

Saxifraga hirculus Linn.

Common in patches in the Polavina moss-bogs. Flowers large, yellow, and handsome.

Saxifraga stellaris comosa Willd.

Collected on St. George August 10.

Saxifraga unalaskensis Sternb.

Collected on Polavina moss bogs August 8.

Chrysosplenium ——.

Collected on Bogoslof hill, St. Paul Island, August 7, 1891.

[Acaulescent or with a single leaf, 1 to 3 inches [25–75 mm.] high, pubescent, purplish; radicle leaves on petioles nearly as long as the stems, pubescent; blade oval, 3 to 5 lines [6–10 mm.] broad, 4- to 5-crenate, nearly glabrous; involucral leaves several, shortly petioled, entire or 3-crenate, longer than the flowers; calyx purple, 3 lines [6 mm.] broad, 4-lobed; stamens 8, half as long as sepals; disk prominent. St. Paul Island, Pribilof group. August 7, 1891. Collected by C. Hart Merriam. It seems nearest *C. alternifolium*. The variety *tetrandrum*, to which all our North American forms have been referred, has smaller greenish flowers, 4 stamens, and more leafy stems.—J. N. Rose.]

Hippurus vulgaris Linn.

Tolerably common on St. George.

Epilobium anagallidifolium Lam.

Collected on St. George August 10.

[A peculiar form [100–125 mm.] 4 to 5 inches high, erect; peduncle 1½ to 2 inches long [38–50 mm.]; capsule single or in

pairs. Dr. Wm. Trelease thinks it must be "the more erect long-pedicelled form" of this species.—J. N. R.]

Heracleum lanatum Michx.

Abundant on both islands; very large and rank, averaging more than a meter (3 feet) in height. In full flower early in August. This plant is called 'poochka' by the natives, who eat the stalks raw after peeling as we peel pie plant; it is not at all bad.

Ligusticum scoticum Linn.

Rather common.

Cœ'oplureum gmelini Ledeb.

Common and rank.

Cornus unalaskensis Ledeb.

Not common or generally distributed. Tolerably common on the moss bogs at Polavina and near Bogoslof hill, on St. Paul, and in places on St. George. In full flower early in August.

Valeriana capitata Pallas.

Tolerably common; past prime before the end of July.

Valeriana sylvatica Banks.

Collected on St. Paul Island by Townsend and identified by Dr. Vasey.

Achillea millefolium Linn.

Common on both islands.

Aster sibiricus Linn.

Common on a moss bog on St. Paul, between the village and Polavina. In full flower early in August.

Chrysanthemum arcticum Linn.

Common in places on both islands, usually in moss bogs; at height of flowering early in August.

Artemisia globularia Cham.

Common in places on St. Paul, particularly about Polavina. St. Paul is the type locality of this species.

[It has rarely been collected, and until now has been a desideratum in the National Herbarium.—J. N. R.]

Artemisia norvegica pacifica Gray.

Specimens determined by Mr. Rose as belonging to this subspecies were collected on both St. Paul and St. George, although the forms inhabiting the different islands are distinguishable.

[The type form of *A. norvegica*, or at least the Rocky Mountain plant which passes as such, is common upon St. Paul. Gray, in the Synoptical Flora, does not extend the range of the species so far north. The stems are [200–305 mm.] 8 to 12 inches high, nearly erect, and very villous (as are also the leaves) except near the base. On St. George occurs a nearly glabrate form, which answers to the var. *pacifica*.—J. N. R.]

Artemisia vulgaris tilesii Ledeb.

Collected near Bogoslof hill, on St. Paul, and near the village on St. George.

[On St. George Island occurs *A. vulgaris*, var. *tilesii*, but the heads are so much larger than *A. vulgaris* that I am inclined to the opinion that this form should have been kept distinct. The form from St. Paul Island, although similar, has somewhat smaller leaves, and these are white-lanate on both sides.—J. N. R.]

Petasites frigida Fries.

Tolerably common on St. Paul; past flowering by August 1.

Senecio pseudo-arnica Less.

Common on St. Paul; just coming into flower the first week in August.

Taraxacum officinale lividum Koch.

Not very common on St. Paul; in flower early in August.

Campanula lasiocarpa Cham.

Common in places on St. Paul, particularly in the drier moss plains; flowers large and handsome.

Campanula pilosa Pallas.

Not common and easily overlooked. Found only between the village and Polavina on St. Paul; in full flower in early August.

Armeria vulgaris Willd.

Common in beds on both islands; past prime.

Primula nivalis Pallas.

Common in a depression at the mouth of Bogoslof cave; not found elsewhere on St. Paul. Common in places on St. George. Nearly past flowering by the end of July.

Androsace chamæjasme Host.

Common on both islands, but nearly out of flower by the end of July.

Trientalis europæa arctica Ledeb.

Tolerably common, but scattering; in full flower the latter part of July.

Gentiana tenella Rottb.

Collected on St. Paul by Townsend and identified by Dr. Vasey.

Gentiana frigida Hænke.

Common and showy on some of the moss bogs near Bogoslof and Polavina on St. Paul; at height of bloom about August 10.

Gentiana glauca Pallas.

Mr. Macoun tells me he found this gentian on St. George.

Polemonium cæruleum Linn.

Abundant on both islands, flowering profusely, and often covering large areas; past prime by the first week in August.

Omphalodes nana chamissonis Herder.

Common in small patches on Bogoslof hill, St. Paul, but nearly out of flower by the first of August.

Mertensia maritima Don.

Common at Northeast Point and along some of the gravel beaches elsewhere on St. Paul. In full flower the latter part of July.

Pedicularis langsdorffii Fisch.

One of the most abundant and conspicuous plants on both islands. Grows in large patches and presents such a diversity of forms as to suggest several species. Flowers past prime by end of July.

Gymnandra gmelini Cham. & Schl.

Collected at the mouth of Bogoslof cave on St. Paul August 7, where it was common and past prime.

Oxyria reniformis Hooker.

Rather common in places, particularly about Bogoslof hill on St. Paul.

Polygonum viviparum Linn.

Abundant on both islands; past prime.

The willows have been determined by Mr. M. S. Bebb as follows:

Salix arctica Pallas.

Collected on Polavina moss bogs, St. Paul, August 8.

Salix phylicoides And.

Collected at Bogoslof hill, St. Paul, August 7.

Salix reticulata Linn.

Abundant on both islands, growing in dense mats on the bogs. Though the branches are long, they are prostrate and buried in the moss, so that the highest leaves rarely reach more than 70 or 80 mm. ($2\frac{3}{4}$ or 3 inches) above the general surface of the bog.

Salix [intermediate between *S. arctica* and *S. ovalifolia*—may possibly be a hybrid.—M. S. Bebb.]

Collected July 30 on St. Paul.

Empetrum nigrum Linn.

Abundant on both islands and forming the covering of large areas. It sometimes forms pure heather bogs, but more often is mixed with moss, usually *Racomitrium*.

Fritillaria kamtschatcensis Ker.

Common on St. George between Zapadnie and the highest part of the island; not seen on St. Paul.

The rushes (*Juncaceæ*) have been determined by Mr. F. V. Coville as follows:

Luzula arcuata unalaschkensis Buchenau.

Collected on St. George Island.

Luzula confusa latifolia Buchenau.

Common on St. Paul.

Luzula campestris sudetica Celakovsky.

Common on St. Paul.

The sedges (*Cyperaceæ*) have been determined by Prof. L. H. Bailey as follows:

Carex alpina Swartz (form).

Collected on St. George Island August 10.

Carex cryptocarpa Meyer (form).

Common on Polavina, St. Paul.

Carex norvegica Schk.

Common with the last species.

Carex rigida bigelovii Tuckerman (= **C. hyperborea** Drejer).

Common on St. Paul.

The grasses have been determined by Dr. George Vasey as follows:

Phleum alpinum Linn.

Common on both islands.

Alopecurus alpinus Linn.

Collected on St. Paul Island.

Alopecurus macounii Vasey.

Collected on St. George Island.

Arctagrostis latifolia Griseb.

Collected on St. Paul Island.

Calamagrostis deschampsioides Trin.

Collected on St. Paul Island.

Deschampsia cæspitosa arctica Vasey.

Common on the old seal rookeries.

Arctophila fulva Rupr.

Collected on St. Paul Island.

Poa arctica R. Br.

Collected on St. Paul Island.

Glyceria angustata Fries.

Common on the abandoned parts of the seal rookeries.

Elymus mollis Trin.

Abundant and rank; the tall grass of the islands.

Ferns are rather scarce on the Pribilof Islands. The specimens collected and brought back by me have been mislaid in the National Herbarium and cannot now be found. The same is true of the club-mosses. The following ferns were collected

on the Pribilof Islands by Mr. C. H. Townsend in 1885 and identified by Dr. George Vasey (see Cruise of the *Corwin* for 1885, 1887, p. 97):

Polypodium vulgare Linn.

Aspidium spinulosum Swartz.

Aspidium lonchitis Swartz.

The following species of *Lycopodium* was identified in the field:

Lycopodium selago Linn.

Found sparingly in a few places, particularly on St. George Island.

Mr. John M. Holzinger has kindly undertaken the determination of the mosses. In this he has been assisted by Mrs. E. G. Britton of New York, Dr. V. F. Brotherus of Helsingfors, Finland, and Dr. C. Warnstorf of Neuruppen, Germany. The latter is sole authority for the *Sphagnums*, in the list of which, owing to the peculiarities of the nomenclature employed, the word '*forma*' and the name following are inserted as given by Dr. Warnstorf in order to avoid the use of pure quadrinomials. The *Dicranum* was determined by Prof. C. R. Barnes of Madison, Wisconsin.

In the case of these *Sphagnums* I fear a transposition of labels has taken place, since most of the specimens were collected on St. George Island and only one or two on St. Paul—the latter from Bogoslof hill.

Species and subspecies preceded by an asterisk (*) were collected by Mr. James M. Macoun on St. Paul Island in July and August, 1891, and described as new by Dr. N. C. Kindberg in the Ottawa Naturalist, vol. v, January 12, 1892, p. 179.

Bartramia ithyphylla Brid.

Collected on St. Paul Island.

Bryum arcticum Bruch.

Collected on St. Paul Island.

* **Bryum brachyneuron** Kindberg.

* **Bryum froudei** Kindberg.

Bryum pendulum Schimp.

Collected on St. Paul Island.

Bryum inclinatum Br. & Sch.

Collected on St. Paul Island.

Ceratodon purpureus Brid.

Collected on St. Paul Island.

* **Ceratodon heterophyllus** Kindberg.

Desmatodon systilius Br. & Sch.

Collected on St. Paul Island.

Dicranum elongatum Schleich.

Collected on St. Paul Island.

Hypnum (Calliergon) cordifolium Hedw.

Collected on St. Paul Island.

Hypnum (Pleurozium) splendens Hedw.

Collected on St. Paul Island.

Hypnum (Hylocomium) squarrosum Linn.

Collected on St. Paul Island.

Hypnum (Hylocomium) triquetrum Linn.

Collected on St. Paul Island.

Hypnum (Brachythecium) rivulare Bruch.

Collected on St. Paul Island.

Mnium subglobosum Br. & Sch.

Collected on St. Paul Island.

Oncophorus wahlenbergii Brid.

Collected on St. George Island.

Orthotrichum lævigatum Zelt.

Collected on St. Paul Island.

Orthotrichum microblephare Schimp.

Collected on St. Paul Island.

Philonotis fontana Brid.

Collected on St. Paul Island.

Polytrichum alpinum Linn.

Collected on St. Paul Island.

Polytrichum strictum Banks.

Collected on St. Paul Island.

Racomitrium microcarpon Brid.

Collected on St. Paul Island.

Racomitrium lanuginosum Brid.

Collected on St. Paul Island.

Tetraplodon mnioides Br. & Sch.

Collected on St. Paul Island.

Webera cucullata Schimp.

Collected on St. Paul Island.

* **Webera canaliculata microcarpa** Kindberg.

* **Didymodon baden-powelli** Kindberg.

Sphagnum fimbriatum arcticum Jens.

Sphagnum fimbriatum arcticum forma **fuscescens** Warnst.

Sphagnum lindbergii microphyllum forma **brachydasyclada** Warnst.

Sphagnum riparium Angstr.

Sphagnum squarrosum imbricatum forma **brachyanoclada** Warnst.

Sphagnum squarrosum semisquarrosum Russ.

The following species of *Hepatica* were collected on St. Paul Island and determined by Prof. L. M. Underwood:

Diplophyllum taxifolium Nees.

Herberta adunca S. F. Gray.

Gymnomitrium coralloides Nees.

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PROCEEDINGS

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ON *CARCHARODON MORTONI* GIBBES.*

BY F. A. LUCAS.

In his Monograph of the Fossil Squalidæ of the United States Gibbes assigns the name *Carcharodon mortoni* to two incomplete teeth, stating that with the exception of a single specimen in the cabinet of F. S. Holmes, of Charleston, he had met with none elsewhere. The species was originally described in the Proceedings of the Academy of Natural Sciences of Philadelphia for 1847, page 266, the descriptions being repeated in the Journal of the Academy for 1848, page 146, and one of the specimens shown in figure 45, plate xxi.

The essential part of the description consists in the statements that "both the outer and inner surfaces are convex and prominent, the latter trebly so," and "the root is immensely thick, an inch and a half, and constitutes more than half the bulk of the tooth." The figure shows the tooth to have been unusually thick and swollen for a tooth of *Carcharodon*, and that the root was irregular in shape.

A. Smith Woodward, in his Catalogue of Fossil Fishes in the British Museum, places *Carcharodon mortoni*, with several other reputed species of the genus, in the list of those "* * * recognized upon the evidence of detached teeth, though it is not improbable that some of the names are synonyms * * *."

* Read before the Biological Society of Washington, Feb. 20, 1892.

Among the specimens of *Carcharodon* in the United States National Museum is a very perfect and beautiful tooth, collected by Ira Sayles in the vicinity of Richmond, Va., which agrees very well with Gibbes' description and figure of *C. mortoni.* Although very thick and massive, the specimen presents a curiously distorted and bulged appearance, precisely as if it had been spread out by pressure on the apex of the tooth. On the anterior face are evidences of injury, and from this has undoubtedly resulted the unusual shape of the tooth. The specimen figured by Gibbes has the same unnatural, swollen look as the tooth in the United States National Museum, and there can be no doubt but that it too is a mere abnormality, possibly caused by a similar accident to the tooth while young.

The extreme rarity of examples of *Carcharodon mortoni* is in accord with the supposition that they are merely abnormal teeth, and as lateral cusps are lacking in the few specimens recorded, *Carcharodon mortoni* Gibbes, should stand as a synonym of *Carcharodon megalodon* Agassiz.

THE FOSSIL FLORA OF THE BOZEMAN COAL FIELD.*

BY F. H. KNOWLTON.

[Abstract.]

The first collection of fossil plants from what is now very generally known as the Bozeman Coal Field, Montana, was made in 1871 by the members of Dr. F. V. Hayden's party while they were encamped at Fort Ellis preparatory to beginning their memorable exploration of the Yellowstone National Park. The actual collecting was done by Dr. A. C. Peale, Mr. W. H. Holmes, and Mr. Joseph Savage, and the specimens were all obtained on the same day and from the same vicinity, although not all at exactly the same spot. As the country was at that time new and unsettled, the nearest fixed point was the military reservation of Fort Ellis, and the specimens were labeled by the various collectors as follows: "Six miles above Spring Cañon (now known as Rocky Cañon), near Fort Ellis, Montana;" "Above Spring Cañon, near Fort Ellis," and "Near Fort Ellis, above coal."

These specimens were identified by Prof. Leo Lesquereux, and represent about 30 species, nearly one-third of which were then regarded as new to science.

In recent years quite extensive additional collections have been made, both at the original localities and a number of newly discovered ones, by Dr. Peale, Mr. W. H. Weed, and myself. These, together with most of the original specimens that are fortunately preserved in the United States National Museum, have furnished the basis of the present examination.

As at present understood, the flora of the Bozeman Coal Field embraces 43 species. Of this number 3 are regarded as new to science, while a number of others are of exceptional biological interest.

Thinnfeldia polymorpha Lx., sp., the *Salisburia polymorpha* Lx., of the original collection, is represented by a great number of finely preserved leaves, which are long, wedge-shaped in outline, narrowed from above the middle downward into a strong, thick petiole, and rounded, erose or irregularly undulate or toothed at the apex. The nervation consists of a strong midvein, continuing to or vanishing just below the apex, and numerous thin,

* Read before the Biological Society of Washington, March 19, 1892.

close, simple veins emerging at an acute angle from it. Associated with these leaves were a small number of beautifully preserved leaves, representing an undescribed species of *Thinnfeldia*, which is long-lanceolate in outline, tapering gradually below into a thick petiole and above into a long, slender acuminate apex. The nervation is the same as in the preceding species. In the same beds with these leaves were found two fruiting catkins, at first thought to represent the fruit of the *Thinnfeldia*, but later decided to represent an undescribed species of *Populus*.

Perhaps the most interesting specimens are a number of ferns representing the fruiting condition of what has been called *Sphenopteris lakesii* Lx., one of the most characteristic species of the Denver formation of Colorado, but now shown to be an Aspidium. At least one-tenth of all the specimens in a very large collection of plants from the Denver formation belong to this *Aspidium lakesii* Lx. sp.*

The principal object of this investigation was to ascertain the light thrown by the plants upon the question of the age of the deposits. Lesquereux referred the plants to his Lower Lignitic or true Laramie.* On the other hand, Professor Ward would incline to place them in the Fort Union beds; but it is now known that he included in his enumeration localities in and about the Yellowstone Park which belong to a higher horizon than the Bozeman Coal Field.

Of the 43 species making up this flora, 3 are new to science and 9 others have never been found outside of these beds, leaving 31 species upon which we must depend in determining the age. Of this number 7 species, of which 3 are doubtful, have been found in the Fort Union beds, 14 in the undoubted Denver formation, 12 species at Carbon and Evanston, Wyoming, the age of which may be Denver, and 19 of the species in the true Laramie. By combining the species common to the undisputed Denver and the localities of Carbon and Evanston we have 19 species, or the same number as found in the true or coal-bearing Laramie. From this it appears that there can be no question but that it belongs to what is generally known as the Laramie, but the evidence of the fossil plants is hardly sufficient to permit a separation into the lower and upper divisions or the true Laramie and the recently differentiated Denver formation.

*All of the new or interesting species will be named, fully described, and illustrated in Bull. U. S. Geological Survey, No. —. In preparation.

*Hayden's Ann. Rept., 1872, p. 409.

NOTE ON LOWER CAMBRIAN FOSSILS FROM COHASSETT, MASS.*

BY CHAS. D. WALCOTT.

In a bowlder of reddish-brown limestone, picked up by Mr. T. A. Watson on Pleasant Beach, Cohassett, Mass., and forwarded to me for examination by Dr. W. O. Crosby, I found two species of Lower Cambrian fossils—*Straparollina remota* Billings, and *Hyolithes communis* Billings. The original specimens of *Straparollina remota* were found in Smith's Sound, Trinity Bay, Newfoundland, in rocks of Lower Cambrian age. This species is very closely allied to *Pleurotomaria* (*Raphistoma*) *attleboroughensis*, Shaler & Foerste from Attleborough, Mass. The same slender species of *Hyolithes* also occurs associated with the Attleborough form.

It is interesting to note the occurrence of Cambrian fossils in eastern Massachusetts, as every discovery of a species identical with the fauna of Newfoundland strengthens the correlation between the two sections.

* Read before the Biological Society of Washington, March 19, 1892.

A NEW GENERIC NAME FOR THE BERING SEA FUR-SEAL.

BY T. S. PALMER.

In 1859 Dr. J. E. Gray placed the northern Fur-Seal in a distinct genus, which he called *Callorhinus*,* and for more than thirty years this name has been almost universally adopted by writers who recognize the generic distinctness of the *Phoca ursina* of Linnæus from the southern Fur-Seals of the genus *Arctocephalus*. The fact seems to have been overlooked, however, that *Callirhinus*† had been previously used in entomology by Blanchard, who, nine years before, proposed it as the name of a genus of Coleoptera. In 1857 *Callirhinus*‡ was again used in herpetology by Girard, who established the genus for a peculiar snake (*Callirhinus patagoniensis*), collected by the Wilkes Expedition on the coast of Patagonia.

Thus the name is preoccupied both in entomology and herpetology, and cannot be used for a genus of mammals. Unfortunately no synonym of *Callorhinus* seems to be available, and it becomes necessary to propose a new generic name for the fur-seal of Bering Sea. The name *Callotaria*§ is therefore proposed as a substitute for *Callorhinus* of Gray.

* Proc. Zool. Soc., London, 1859, 359.

† Cat. Collect. Ent., 1850, 176.

‡ Proc. Acad. Nat. Sci., Phila., 1857, 182.

§ *Καλός*, beautiful; *Otaria*, a genus of Fur-Seals.

DESCRIPTION OF A NEW PRAIRIE DOG (CYNOMYS MEXICANUS) FROM MEXICO.*

BY DR. C. HART MERRIAM.

In March, 1891, Mr. Clark P. Streator collected a series of ten skins and skulls of Prairie Dogs at La Ventura, in the extreme southeastern corner of the Province of Coahuila, Mexico, 220 miles south of Laredo, on the boundary between Texas and Mexico. Mr. Streator writes that the colony from which these animals were obtained was the largest he had ever seen. The species proves to be new. It resembles the common Prairie Dog of the Great Plains (*C. ludovicianus*), but differs from it in being somewhat larger and in having a much longer tail. The tail differs further from that of any known Prairie Dog in the extent and intensity of the black on the terminal portion. The black covers the distal half below and forms a submarginal band around the terminal half above, being both more extensive and blacker in color than in *ludovicianus*.

The new species may be known by the following description:

Cynomys mexicanus sp. nov.

Type No. $\{\frac{26423}{33836}\}$ ♂ ad. U. S. National Museum (Department of Agriculture Collection). From La Ventura, Coahuila, Mexico. Mar. 24, '91. Collected by Clark P. Streator. (Original No. 625.)

Measurements.—Total length, 419; tail vertebræ, 107; hairs, 24 + [worn off at tips]; hind foot, 63.

General Characters.—The largest species of the genus: similar to *Cynomys ludovicianus*, but larger, with longer and blacker tail.

Color.—Upper parts everywhere grizzled buffy-fulvous, sparsely mixed with long black hairs; under parts and feet buffy. Tail above: concolor with the back, but with a broad submarginal band and tip of black, which reaches back more than half the length of the tail. Tail below: proximal half buffy like belly, washed with fulvous; distal half black, grizzled with buffy, from the color of the basal part of the hairs, which shows through.

The type specimen has not completed the spring molt, and the posterior two-thirds of the back is pale rufus from the wearing away of the light tips of the hairs, bringing the subapical rufus zone to the surface. Most of the specimens have completed the molt.

* Read before the Biological Society of Washington, May 14, 1892.

Cranial Characters.—Compared with *C. ludovicianus* the skull is broader and shorter, with shorter nasal bones, postorbital processes, and zygomatic arches; jugals with antero-inferior angle not only thickened to form a triangular plate, but produced downward so as to overhang and protect from the outside the fossa beneath; horizontal part of jugal broader and shorter; ascending arm of jugal much thinner and not forming a noticeable plate between maxillary and lachrymal; audital bullæ larger and more inflated; basi-occipital narrower; frontal shield more concave; posterior border of inflected angle of mandible more nearly at right agles to axis of jaw (more squarely truncated); dentition less massive; anterior face of incisors strongly yellow (instead of white or faintly straw-colored); upper incisor with an indistinct groove in front of the inner half.

The length of the nasals equals the distance from the anterior lip of the foramen magnum to the posterior edge of the palate. In *C. ludovicianus* the nasals are much longer.

In cranial characters *C. ludovicianus arizonensis* of Mearns, from southern Arizona, is in some respects intermediate between true *ludovicianus* and *mexicanus*, especially in the unusual development of the triangular plate of the jugal, size of the audital bullæ, and breadth of basi-occipital. In the other cranial characters here pointed out, *C. mexicanus* differs from *C. l. arizonensis* as much as from *C. ludovicianus* proper.

Measurements of Specimens Collected of Cynomys mexicanus.

U. S. National Museum No.		Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ.	Hind foot.
Skin.	Skull.							
26426	33839	622	La Ventura, Coahuila, Mexico.	Mar. 24, '91	♂	430	106	64
26422	33835	623	.....do.....	...do.....	♂	422	114	62
26429	33842	624	.....do.....	...do.....	♂	415	102	59
26423	33836	625	.....do.....	...do.....	♂	419	107	63*
26428	33841	626	.....do.....	...do.....	♀	415	103	61
26425	33838	627	.....do.....	...do.....	♀	390	94	62
26421	33834	628	.....do.....	...do.....	♀	400	99	60
26427	33840	629	.....do.....	...do.....	♀	392	102	61
26424	33837	630	.....do.....	...do.....	♀	398	104	62
26430	33843	631	.....do.....	...do.....	♀	383	94	59

* Type.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

DESCRIPTION OF A NEW GENUS AND SPECIES OF MURINE RODENT (*XENOMYS NELSONI*) FROM THE STATE OF COLIMA, WESTERN MEXICO.

BY C. HART MERRIAM, M. D.

Among the many interesting mammals recently collected by Mr. E. W. Nelson in western Mexico is a handsome rat-like rodent which seems to be not only an undescribed species, but the type of a new genus. In form and general external appearance it looks like a rather small wood rat of the genus *Neotoma*, but differs from the members of that genus, and in fact from all other known North American murines, in having a large and clearly defined whitish spot over each eye and another (though less conspicuous) below each ear. The upper lips and cheeks also are white more than half way to the eyes, giving the animal a very pretty as well as unusual physiognomy. The color of the back and upper parts generally is deep tawny red or fulvous, while the under parts are creamy white. The skull and teeth present a combination of characters so unlike those of any known rodent that a new genus must be framed for its reception. While resembling *Neotoma* more closely than any other genus, it differs from it in many important characters. With a skull much like that of *Neotoma mexicana*, it has well developed supraorbital

beads like *Nyctomys*, large lachrymals, a large interparietal, and large and greatly inflated audital bullæ, which differ from those of any murine with which I am acquainted and resemble those of some of the carnivores. In dentition it combines the 3-rooted upper molars of the true murines with the non-tubercular prismatic grinding crowns of the arvicolines, and has the broadly rounded alternating closed triangles of *Phenacomys*, only even more crowded.

The new genus may be characterized as follows:

Xenomys * gen. nov.

Skull resembling that of *Neotoma* in general form and appearance, but differing in possessing marked elevated and laterally projecting supraorbital beads, much larger and heavier lachrymals, greatly enlarged and inflated audital bullæ, which are elongated antero-posteriorly and parallel to the axis of the skull and to each other, instead of being set obliquely as in *Neotoma* (in which genus they would meet in the middle of the pterygoid fossa if produced forward along their strongly convergent axes). The anterior border of the squamosal above the zygomatic process is marked by a projecting vertical ridge corresponding to the postorbital process of *Cuniculus*, *Myodes*, and *Phenacomys*, and serving to indicate the separation of the (small) temporal from the (large) orbital fossa. Posteriorly the squamosal does not reach the occiput as it does in *Neotoma*, but ends about half-way between the posterior root of the zygoma and the occiput. Its posterior spicule reaches the mastoid. The paroccipital processes are long and stout. The interparietal is very large and somewhat diamond-shaped. The condyloid process of the mandible is long and slender and higher than the coronoid process.

Dental Characters.—Molars truly rooted; the roots closed at the tips; upper molars 3-rooted; lower molars 2-rooted. First upper molar with anterior and posterior roots subcylindric and a broad flat root in the middle on the inner side, the latter slightly notched at the tip and having the appearance of two roots grown together. Between the middle and posterior root in the specimen examined is a small needle-like auxiliary or supplemental root about half the length of the others; middle upper molar with 2 anterior and 1 posterior roots, the anterior on the inner side about double the size of the others; last upper molar with

* *Xenomys:* from ξένος, strange, and μῦς, mouse.

2 anterior and 1 posterior roots; molar series large and heavy, much broader than in *Neotoma* or *Arvicola*; crowns flat, prismatic, non-tubercular, with broadly rounded and crowded alternating closed triangles as in *Phenacomys* and *Arvicola* (only much more crowded) and bearing no resemblance to the narrow transversely elongated loops of *Neotoma*; crown of last lower molar deeply incised on the inner face a little anterior to the middle by a narrow trenchant reëntrant angle which carries a fold of enamel obliquely forward and outward across the tooth. On the outer side a short reëntrant angle pushes a loop of enamel obliquely forward and inward toward the middle of the long fold from the opposite side, leaving an anterior loop, a posterior loop, and a small closed or nearly closed triangle on the outside about the middle of the tooth. The resulting pattern is shaped like the letter **S**, with a small closed triangle on the outer side of the convexity, thus differing widely both from the 3 transverse loops of *Arvicola* and *Phenacomys* and from the 2 transverse loops or figure-8 pattern of *Neotoma*; upper incisors plane or with a faint bead on each side of the anterior face, which is nearly flat and yellow; lower incisors plane, convex in front, pointed.

In describing genera from single species it is not always possible to distinguish clearly between generic and specific characters, unless indeed the genus is based on a single character. In the event of the discovery of additional species of the present genus it may be found that some of the characters here ranked as generic are only specific or, on the other hand, that some here considered specific are really generic.

The species may be known from the following description:

Xenomys nelsoni* sp. nov.

Type No. $\frac{33281}{45286}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From Hacienda Magdalena, Colima, Mexico, March 21, 1892. Collected by E. W. Nelson. (Original number, 2288.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 300; tail vertebræ, 143; hairs, 6; hind foot, 30; ear (in dry skin) from crown, 18; from anterior root, 22.

General Characters.—Size about that of a half or two-thirds grown rat, or nearly equaling *Neotoma mexicana;* tail a little shorter than head and body, well haired, particularly above; face ornamented by a distinct whitish spot over each eye and a

*Named in honor of its collector, Mr. E. W. Nelson.

less distinct one under each ear; color of upper parts rich fulvous; under parts white; ears about half as long as the head and nearly naked (sparsely clothed with fine, inconspicuous hairs); whiskers reaching back to shoulders; fur soft.

Color.—Upper parts fulvous or tawny-rufous, palest on the head and brightest over the rump, flanks, and hips; back sparsely mixed with black-tipped hairs; an ill-defined dusky ring around each eye, above which is a whitish spot about as large as the eye itself; a less distinct whitish spot just below the inferior root of the ear; upper lips white, the white color extending up on the cheeks more than half way to the eyes; sides of face below eyes and ears washed with fulvous, whiskers blackish; tail concolor, dark umber-brown all round; upper surfaces of feet whitish, more or less clouded with dusky (varying considerably in the three specimens); under parts creamy white to the very roots of the hairs except along the sides of the belly, where the basal part of the fur is plumbeous; line of demarkation between colors of upper and lower parts everywhere sharp and distinct.

An immature but full-grown specimen from Armeria, Colima (collected March 2, 1892), has a small whitish lanuginous tuft in front of the anterior base of each ear, in addition to the markings of the specimens from Hacienda Magdalena, already described. This may be characteristic of the winter pelage. The same specimen has white feet, and the white of the face is more extensive.

Cranial Characters.—The principal cranial peculiarities have been pointed out in the generic description. The great size of the audital bullæ is doubtless a specific character, though not the direction of their axes. The bullæ are broader anteriorly than posteriorly, and curve slightly outward in front of the meatus, where the inflated portion is much more extensive than that behind it. The large size of the interparietal also is in all probability a specific feature. In one of the three skulls its antero-posterior diameter along the median line equals that of the parietals. The ascending branches of the premaxillaries reach as far back as the nasals, which end on a line with the lachrymals.

Dental Characters.—(The generic characters already mentioned are not repeated here.) First upper molar with crown more than half as broad as long; outer side straight; inner side

strongly convex, with one anterior and one posterior closed loop, and one external and two internal lateral closed triangles. Middle and last upper molars each with one anterior and one posterior closed loop, and one lateral closed triangle on each side (sometimes the lateral triangles are not quite closed in the last tooth). The anterior loops of the second and third upper molars are strongly pyriform, as in *Phenacomys*.

First lower molar with anterior half bent strongly outward, the anterior loop looking outward instead of forward. This tooth has an anterior loop, a posterior loop, an external lateral closed triangle, and two internal lateral triangles, the posterior of which is closed. Second lower molar with one anterior and one posterior closed transverse loop, and one lateral closed triangle on each side; last lower molar with an anterior oblique closed loop, a posterior oblique closed loop, and a lateral closed (or nearly closed) triangle on the outer side. (This tooth is described more in detail in the generic diagnosis.)

Haunts and Habits.—Almost nothing is known of the life history of this interesting and heretofore unknown animal. Respecting the specimens from Hacienda Magdalena Mr. Nelson writes: "Not common. The two specimens obtained were caught in hollow trees." Another "was taken in the low dense woods near the mouth of the Armeria River. They live in hollow trees."

Measurements (taken in flesh) of Xenomys nelsoni.

U. S. National Museum No.		Original No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ.	Hind foot.
Skin.	Skull.							
33280	45285	1972	Armeria, Colima, Mexico.	Mar. 2, '92	♂	315	155	31
33281	45286	2288	Hacienda Magdalena, Colima, Mexico.	Mar. 21, '92	♂	300	143	30*
33282	45287	2318	Hacienda Magdalena, Colima, Mexico.	Mar. 23, '92	♂	335	170	32

*Type.

DESCRIPTIONS OF NINE NEW MAMMALS COLLECTED BY E. W. NELSON IN THE STATES OF COLIMA AND JALISCO, MEXICO.

BY C. HART MERRIAM, M. D.

The well known ornithologist, Mr. E. W. Nelson, whose zeal and indefatigable energy have led him to penetrate many remote and little-known regions for the purpose of collecting mammals and birds, and whose efforts have been rewarded by the discovery of many new species—from the Arctic regions as well as the arid deserts and lofty mountains of the United States—has recently directed his steps into Mexico, in the interest of the United States Department of Agriculture.

Diagnoses are here given of nine new mammals contained in the collections sent by him from Colima and Jalisco, in addition to the new genus and species just described (*Xenomys nelsoni*).* Illustrations of cranial and dental characters will appear in a later paper.

Genus Geomys.

The collection contains three new pocket gophers of the genus *Geomys:* a small species from the high mountains of Jalisco (*G. nelsoni*); a large species from the plain of Colima (*G. fumosus*), and a large species from the valley of Zapotlan (*G. gymnurus*). They may be known from the following descriptions:

Geomys nelsoni sp. nov.

Type No. $\frac{33557}{45622}$ old ♂. U. S. National Museum (Department of Agriculture collection). From north slope of the Sierra Nevada de Colima, Jalisco, Mexico (altitude 1,980 meters, or 6,500 feet), April 11, 1892. Collected by E. W. Nelson. (Original number, 2436.)

Measurements (in millimeters, taken from dry skin of type, slightly overstuffed; this is the largest and oldest of the

* Proc. Biol. Soc. Wash., vol. vii, Sept., 1892, pp. 159–163.

seven specimens).—Total length, 250; tail vertebræ, 80; hind foot, 30.

Cranial Measurements.—Total length of skull of type, 42; basilar length (inferior lip of foramen magnum to posterior rim of alveolus of incisor), 35; zygomatic breadth, 25; upper molar series on alveolæ, 9.

General Characters.—Upper incisors bisected by a median sulcus; size smallest of the known species; nose with a vertically elongated naked pad or callosity, above which the hairs are short, stiff, with the tips worn off; tail rather long and naked; claws moderate; color deep and bright chestnut above and below, much deeper than in *Geomys tuza* from Florida and the eastern Gulf region. An immature but full-grown specimen (No. 33585) is dusky in color, and one in the molt has the anterior parts chestnut and the posterior dusky.

Cranial Characters.—*Geomys nelsoni* differs so widely from any of the species having the upper incisors bisected by a single groove that detailed comparison is hardly necessary. Contrasted with *G. clarkii* from the Rio Grande region, it may be distinguished at a glance by its much smaller size, more squarely truncated zygomatic arches, absence of triangular plate at the antero-inferior angle of the zygomatic arch, relatively longer and more slender nasals, smaller and more smoothly rounded audital bullæ, and mastoids which occupy much less space on the occipital plane, where they present a subquadrangular surface.

Mr. Nelson states that the species "was found only in some fields at the upper ranch at the foot of the main north slope of the Sierra Nevada de Colima, Jalisco, in the upper border of the lower pine belt, at about 6,500 feet altitude, where it was common, and was found in company with the large species" [here described as *Geomys gymnurus*]. Seven specimens were secured.

Geomys fumosus sp. nov.

Type No. $\frac{33202}{45207}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From Colima City, Mexico, March 27, 1892. Collected by E. W. Nelson. (Original number, 2338.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 292; tail vertebræ, 80; hind foot, 41.

General Characters.—Size medium, about equalling *G. bursarius*;

upper incisors with a single median sulcus: pelage coarse, but not nearly so harsh as in *G. hispidus;* fore claws rather weak for a *Geomys;* tail appearing naked, but sparsely sprinkled with a few inconspicuous hairs; hind feet nearly naked: belly scant haired, the skin showing through; no nasal pad. *Geomys fumosus* seems to be more closely related to *Geomys hispidus* than to any other known member of the genus, but it is smaller than *hispidus;* much darker in color; the sulcus in the upper incisor is median instead of lateral; the cranium is much narrower and less flat interorbitally, and the angular processes of the mandible are conspicuously longer and project out laterally to a much greater distance.

Color.—Upper parts dark sooty brown, the tips of the hairs faintly washed in places with reddish brown; under parts indistinctly paler.

Mr. Nelson contributes the following information respecting the haunts of this species: In the vicinity of Armeria, at an altitude of about 200 feet above the sea, a few pocket gopher's hills were found, but none of the animals were taken. From there up the course of the Armeria river on the plain of Colima the hills become more and more numerous until from about 800 to 2,500 feet they are common in places. In a flat overgrown with wild fig, mesquit, and cocoanut palm trees near Colima City I secured eleven of these animals. They seem to live in isolated and limited colonies, between which, in apparently equally favorable ground, they occur singly and rarely. One colony of considerable size occupies an open grassy area in the limestone belt between Colima and the volcano. Others were seen along the sandy border of the Armeria river bottom, where a growth of low bushes had started up, and another in some thick thorny woods on a dry bench bordering the Colima river a few miles below the city.

Geomys gymnurus sp. nov.

Type No. $\frac{33579}{45614}$ ♀ ad. U. S. National Museum (Department of Agriculture collection). From Zapotlan, Jalisco, Mexico, April 16, 1892. Collected by E. W. Nelson. (Original number, 2460.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 342; tail vertebræ, 93; hind foot, 50.

General Characters.—Size very large, about equalling *G. mexicanus*, but differing conspicuously from that species in having the tail naked instead of hairy. Upper incisors with a single median furrow. Color of type and other specimens from the Zapotlan valley, uniform reddish brown with a dusky or fuliginous patch behind each ear and a larger one on the nose. Specimens from the base of the neighboring mountains (Sierra Nevada de Colima, Jalisco), here referred to the same species, are much darker, and two from high altitudes are uniform dark sooty-plumbeous. The latter, Mr. Nelson states in his notes, occur in company with the small species here described as *Geomys nelsoni*.

The skull of this species is huge, and the under jaw in particular bears a striking superficial resemblance to that of *Aplodontia*. The angular processes project out laterally to a considerably greater distance than in *Geomys mexicanus*.

Genus Neotoma.

The collection contains a series of two heretofore unknown species of *Neotoma*. The first of these, obtained at Manzanillo, in the state of Colima, is the largest and handsomest species known, and I take pleasure in naming it *Neotoma alleni*, after Dr. J. A. Allen, of the American Museum of Natural History, in New York, in recognition of his valuable contributions to the mammalogy of Mexico. It is remarkable that so large and conspicuous an animal should have escaped description until the present time, particularly since it is common in the immediate neighborhood of one of the principal seaports of western Mexico. In the pattern of the enamel folds of the last lower molar it differs conspicuously from typical *Neotoma*, as pointed out in detail beyond, and may merit subgeneric recognition. It is represented by more than 20 specimens in excellent condition.

The other species (*N. tenuicauda*) is much smaller, less than half the size of *N. alleni*, and was obtained in the Sierra Nevada de Colima, in the state of Jalisco. It is represented by seven specimens.

The two species may be known from the accompanying descriptions:

Neotoma alleni sp. nov.

Type No. $\frac{32709}{44632}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From Manzanillo, Colima, Mexico, January 26, 1892. Collected by E. W. Nelson. (Original number, 1796.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 472; tail vertebræ, 225; hairs, 4; hind foot, 46; ear (in dry skin) from anterior root, 29.

General Characters.—Size much larger than any species heretofore described; ears rather large and sparsely clothed with fine hairs on the posterior surfaces; tail shorter than the head and body, blackish, sparsely haired, the annulations and scales distinctly visible above as well as below; upper parts deep tawny-red or rusty.

Color.—Upper parts from forehead to base of tail deep fulvous or tawny-ferruginous; nose and sides of face mouse-gray, tinged with bluish in some specimens; under surface whitish, the tips of the hair only being white and the plumbeous basal portion showing through; upper surfaces of feet whitish, more or less clouded with dusky; tail blackish all round.

Cranial Characters.—Skull largest of the genus. Total length of type, 53; basilar length (from inferior lip of foramen magnum to posterior alveolus of incisor), 44; zygomatic breadth, 27.50; length of upper molar series on alveolus, 11; cranium strongly marked by muscular impressions; superciliary ridge strongly elevated and continued posteriorly across the outer half of the parietals and interparietal to the occiput; interparietal subquadrate with a postero-lateral wing on each side; ascending ramus of premaxillary short, barely reaching plane of lachrymals, and but slightly exceeding the nasals; antorbital slit with a tubercle at inferior base; audital bullæ small, connected by a bony process with the hamular processes of the pterygoids; molar series very large and heavy, about one-fourth the basilar length of the skull; first and second upper molars with a lateral closed triangle on each side; last lower molar shaped like the letter **S**, as in *Xenomys*, but differing from *Xenomys* in having a shallow reëntrant angle on the outer side opposite the deep fold from the inner side; infracondyloid notch of mandible broadly open and but slightly concave.

Mr. Nelson writes that in the neighborhood of Manzanillo this

large and handsome wood rat "is abundant everywhere on the lower parts of the wooded hill slopes and adjacent dry ground covered with mesquite and other seed-bearing trees. It is strictly nocturnal, and usually lives in holes or burrows at the foot of a tree or under some convenient shelter, from which its pathway or trail, neatly cleared of brush, leaves, and twigs, leads away. It lives also in ledges of loose rock, and in a few such places small collections of sticks, shells of land crabs, and other *Neotoma* bric-a-brac were found. These were rare, however. Where the animals are common these trails intersect one another and form a network on the brush and tree-covered slopes. Sometimes their runways reach down on the low wooded flats close to the coast, but they are not common in such places."

Neotoma tenuicauda sp. nov.

Type No. $\frac{33594}{45629}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From north slope of the Sierra Nevada de Colima, Jalisco, Mexico (altitude 3,650 meters, or 12,000 feet), April 13, 1892. Collected by E. W. Nelson. (Original number, 2446.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 340; tail vertebræ, 160; hind foot, 31.

General Characters.—Size smallest of the known species, being slightly smaller even than *N. mexicana;* tail *slender* and sparsely haired, bicolor; ears rather small, sparsely haired; fore feet soiled white; hind feet whitish, clouded with dusky.

Color.—Upper parts dark brown, more or less suffused with yellowish fulvous, particularly on the neck and shoulders, passing into dark fulvous on the flanks and hips; under parts soiled white (the plumbeous basal color showing through), with a salmon patch on the inner side of each axilla; tail bicolor, dusky above and whitish below; fore feet and ankles soiled white; hind feet whitish, strongly clouded with dusky proximally (the dusky fading out in passing over the metatarsals); toes pure white.

Cranial and Dental Characters.—Nasals rather short, not reaching plane of lachrymals, ascending rami of premaxillæ ending on plane of lachrymals; audital bullæ rather large for a *Neotoma;* molar series narrow, with sharply angular prisms; first upper molar with an internal lateral closed triangle; lower molars with

the transverse loops long and narrow, the inner reëntrant angles about twice as deep as the outer; first lower molar with anterior loop double, forming a projecting antero-external loop and an internal lateral loop.

Mr. Nelson says of it: "A small wood rat was found living in crevices in the rocks, at an elevation of 12,000 feet, on the north slope of the Sierra Nevada de Colima." This is in the upper fir belt.

At Zapotlan, in the valley below, he obtained five specimens of a form similar to the present but slightly larger and with concolor tails.

Genus **Sitomys.**

Among the small rodents collected are numerous specimens of two mice which in general appearance look almost precisely like the common house mouse (*Mus musculus*), but are still smaller and have shorter tails. They may be roughly separated into two series, according to size. The smaller is a form (or subspecies) of *Sitomys taylori*, which was described by Mr. Oldfield Thomas a few years ago from specimens obtained at San Diego, Duval county, Texas; the larger apparently is an undescribed species, here designated as

Sitomys musculus sp. nov.

Type No. $\frac{33487}{45460}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From near Colima City, Mexico, March 9, 1892. Collected by E. W. Nelson. (Original number, 2055.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 123; tail vertebræ, 48; hairs, 1; hind foot, 17; ear (in dry skin) from anterior root, 5.5.

General Characters.—In size, color, and external appearance *Sitomys musculus* looks almost exactly like a small common house mouse (*Mus musculus*), except that the tail is shorter. It is smaller than any known species of *Sitomys* except *S. taylori*, from which it differs in being somewhat larger, with longer ears and tail and larger hind feet. It is not quite so dark as typical *S. taylori*, either above or below. The hind feet measure 16 or 17 mm., while those of *S. taylori* measure only 13 or 13.5. Twenty-

three specimens have been received from Mr. Nelson from Colima City and Armeria, Colima, and from Plantinar and Zapotlan, Jalisco.

Color.—Upper parts uniform drab-gray, slightly grizzled with black-tipped hairs and faintly tinged with tawny, precisely as in *Mus musculus;* under parts buffy, the basal part of the hairs plumbeous, without sharp line of demarkation; tail above, concolor with back; slightly paler below.

Cranial and Dental Characters.—Skull similar to that of *S. taylori*, but larger; first and second upper molars relatively shorter and thicker; anterior cusp of first upper molar not distinctly (if at all) bi-tuberculate when young; in *S. taylori* it is conspicuously bi-tuberculate.

Genus Arvicola.

Mr. Nelson obtained a series of 18 specimens of a new species of *Arvicola* on the Sierra Nevada de Colima, in the state of Jalisco, Mexico, during the latter part of April, 1892. The species belongs to the western section of the subgenus *Mynomes* (characterized by lacking the postero-internal loop of the middle upper molar) and is related to *Arvicola mogollonensis* of Mearns from the pine plateau region of Arizona, but is larger, with the tail and hind feet longer, and is much darker in color. It differs also in cranial characters.

Arvicola phæus sp. nov.

Type No. $\frac{33605}{45640}$ ♀ ad. U. S. National Museum (Department of Agriculture collection). From north slope of the Sierra Nevada de Colima, Jalisco, Mexico (altitude, 10,000 feet), April 21, 1892. Collected by E. W. Nelson. (Original number, 2516.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 155; tail vertebræ, 34; hairs, 4; hind foot, 20½; ear from anterior root, 14 (in dry skin).

Color.—Upper parts dark bistre, grizzled, and thickly interspersed with long black-tipped hairs; under parts plumbeous, more or less washed with dilute tawny-drab; tail indistinctly bicolor, sooty above, paler below.

Cranial and Dental Characters.—Skull resembling that of *Arvicola mogollonensis* in general form and in the vertical expansion of the middle part of the zygomatic arch and the deflection of the short nasals. The incisive foramina are a little more than 1½ times the length of the premaxillary symphesis; the audital bullæ are large and smoothly rounded; the last upper molar has two lateral closed triangles on its outer side, and the first lower molar has 3 lateral closed triangles on the inner and two on the outer side as in typical *Mynomes*, but the middle upper molar has no trace of the postero-lateral loop characteristic of the members of that section from the eastern part of North America.

Genus Sorex.

No shrew of the restricted genus *Sorex* has been heretofore known from Mexico, though a single species has been described by Alston from Coban, Guatemala. It is of special interest therefore to record the fact that Mr. Nelson had the good fortune to secure specimens of two species on the north slope of the lofty Sierra de Colima, in Jalisco, neither of which appear to have been described.

One of these, which I have named *Sorex oreopolus*, was found in *Arvicola* runways in grassy places at an altitude of 3,050 meters (10,000 feet); the other, here named *Sorex saussurei*, was captured at the base of a rocky ledge in a sheltered cañon at an altitude of about 2,440 meters (8,000 feet). The latter species may be readily distinguished from the former by its much longer ears and tail, by the color of its under parts, and by cranial proportions. In the relative size of the lateral unicuspidate teeth both of these shrews resemble *Sorex dobsoni* from the Saw Tooth mountains of Idaho, though the height of the teeth is much less.* The first and second upper unicuspids are subequal; the third and fourth likewise are subequal and about half the size of the first and second; the fifth is in the tooth row and distinctly visible from the outside, but is considerably smaller in *saussurei* than in *oreopolus*.

Three specimens of *S. oreopolus* and two of *S. saussurei* were obtained. They may be known from the following descriptions:

*See North American Fauna, No. 5, 1891, p. 33.

Sorex oreopolus* sp. nov.

Type No. $\frac{33663}{15698}$ ♂ ad. U. S. National Museum (Department of Agriculture collection). From the Sierra de Colima, Jalisco, Mexico (altitude, 10,000 feet), April 22, 1892. Collected by E. W. Nelson. (Original number, 2517.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 106; tail vertebræ, 36; hairs, 1½; hind foot, 13.

General Characters.—Size rather large; tail short; ears short, scarcely protruding beyond the fur.

Color.—Upper parts uniform sepia-brown, with a 'pepper-and-salt' appearance; under parts uniform drab; tail bicolor, concolor with the upper and lower surfaces of the body, but darker near the tip on the under side.

Cranial and Dental Characters.—Skull smaller than that of *S. oreopolus*, with rostral portion narrower and more compressed; first and second lateral unicuspidate teeth subequal and largest; third and fourth subequal and about half as large as the first and second; fifth rather large, plainly visible to the unaided eye from the outer side, and wholly in the tooth row; considerably longer antero-posteriorly than in *S. saussurei*.

Sorex saussurei† sp. nov.

Type No. $\frac{33667}{45702}$ ♀ ad. U. S. National Museum (Department of Agriculture collection). From the Sierra de Colima, Jalisco, Mexico (altitude 8,000 feet), April 23, 1892. Collected by E. W. Nelson. (Original number, 2538.)

Measurements (in millimeters, taken in flesh by collector).—Total length, 115; tail vertebræ, 48; hind foot, 14.

General Characters.—Size about equalling that of *Sorex oreopolus*, but with tail and ears considerably longer (tail about as long as the body without the head; ears protruding conspicuously beyond the fur).

Color.—Upper parts sepia-brown, slightly darker posteriorly; under parts drab-gray on the throat and breast, clouded with

* Ὀρεοπόλος, mountain-haunting.

† Named in honor of Professor Henri De Saussure, of Geneva, Switzerland, who described a number of new mammals from Mexico more than thirty years ago. (Rev. et Mag. Zool., xii, 1860; xiii, 1861; xv, 1863).

sooty over the belly; tail above concolor with the back, slightly paler on the basal half below.

Cranial Characters.—Skull somewhat larger than that of *S. orcopolus*, with rostral portion more swollen; first and second lateral unicuspidate teeth subequal and largest; third and fourth subequal and about half the size of the first and second; fifth in the tooth row and distinctly visible from the outside. Though the first and second unicuspids are apparently equal in height, the second is really slightly larger than the first owing to its higher point of origin.

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THE OCCURRENCE OF COOPER'S LEMMING MOUSE (*SYNAPTOMYS COOPERI*) IN THE ATLANTIC STATES.*

BY DR. C. HART MERRIAM.

Synaptomys cooperi is one of the rarest of North American mammals. Both genus and species were described and named 35 years ago by Professor Baird in a peculiarly informal way, in some remarks under the genus *Myodes* in his great work on mammals published in 1857 (Pacific R. R. Reports, vol. VIII, 1857, pp. 556–558). The description was based on a very imperfect specimen from an unknown locality, transmitted by Mr. William Cooper, of Hoboken, New Jersey. Of its probable source Professor Baird said: "The animal is undoubtedly North American, probably from the New England states or New York; possibly from Iowa or Minnesota." The type specimen lacked three feet, the tail, and the skin of the head. Another badly damaged skin, lacking both head and skull, accompanied it and may or may not have belonged to the same species.

The next specimen of which we have any record was captured near Brookville, Indiana, in 1866, by Rufus Haymond, and by him transmitted to the Smithsonian, but its identity evidently was not made known until much later, for the species is not mentioned by Haymond in his annotated list of the 'Mammals found at the present time in Franklin County,' Indiana, pub-

* Read at a meeting of the Biological Society of Washington, Nov. 5, 1892.

lished in 1869 (First Annual Report, Geol. Surv. Indiana, 1869, 203–208).

The first published record after Baird's original description seems to have appeared in 1874 in Coues' 'Synopsis of the Muridæ of North America' (Proc. Acad. Nat. Sci., Phila., 1874, 192–194). In this paper Coues mentioned specimens from Indiana, Illinois, Minnesota, Kansas, Oregon, and Alaska, but it is probable, if not absolutely certain, that those from Oregon and Alaska do not pertain to the species under consideration.

The only locality in which *Synaptomys* has been found in anything like abundance is the neighborhood of Brookville, Indiana, where Mr. Edgar R. Quick and Amos W. Butler have obtained a number of specimens. This, moreover, is the easternmost locality from which any positive record has been published. (See Am. Nat., vol. XIX, Feb., 1885, pp. 113–118.)

In April, 1888, Dr. A. K. Fisher, while hunting at Munson Hill, Virginia (only about five miles from the city of Washington), found a number of 'pellets' of the Long-eared owl (*Asio wilsonianus*) under a tree in which one of these owls habitually roosted. In examining these 'pellets,' which were made up almost wholly of the remains of small mammals, I was surprised not only at the large number of individuals and species represented, but also at the discovery among the rest of three more or less perfect skulls of *Synaptomys cooperi*. The total number of skulls found in these pellets was 176, of which 137 were of mice, 26 of shrews, and 13 of birds. The mice and shrews were positively identified as follows:

Arvicola riparius	95
Arvicola pinetorum	24
Mus musculus	15
Synaptomys cooperi	3
Blarina exilipes	23
Blarina brevicauda	3
Total	163

A year and a half afterward a single skull was taken from the stomach of a Barred owl (*Syrnium nebulosum*) killed at Alfred Center, New York, October 11, 1889, and still later another was found in the stomach of a Red-tailed hawk (*Buteo borealis*) killed at Sandy Spring, Maryland, March 24, 1890. These specimens were exhibited at one of the meetings of the Biological Society,

but publication was deferred in the hope that a specimen of the animal itself might be obtained.

During the past season I had the good fortune to capture two specimens of *Synaptomys* on the summit of Roan Mountain, North Carolina, in traps set for shrews (*Sorex*) and red-backed mice (*Evotomys*). The first of these, an adult male, was caught August 29, 1892, at the mouth of its runway in a bed of dry moss overrun by mountain bluets (*Houstonia serpyllifolia*) in the edge of a grove of balsam firs (*Abies fraseri*). The second specimen, an adult female, was caught September 8 in a wet sphagnum bog near the spring that supplies the Cloudland Hotel with water. Both were taken at an altitude of 1,830 meters (above 6,000 ft.). Before leaving the mountain these specimens were shown to Mr. Elmer R. Edson, a young man temporarily residing there. Mr. Edson promised to set the 'cyclone' traps left with him, in the hope of securing additional specimens, and has been rewarded by the capture of two adults—one in the same sphagnous bog from which my second specimen came, the other in a grove of balsams on the dry summit. In view of the records here published from North Carolina, Virginia, Maryland, and New York, it seems not unlikely that Baird's type really came from the latter State, or possibly even from New Jersey, the State in which the donor of the specimen, Mr. Cooper, lived.

Persons interested in the capture of rare mammals will do well to keep a sharp lookout for this species in the cooler parts of Pennsylvania and New Jersey.

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New genera and species are printed in **heavy type**; synonyms in *italics*.

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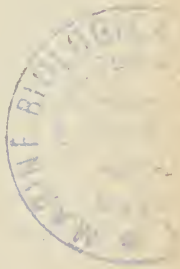

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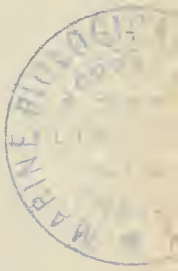

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